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FOREST SERVICE
GREAT BASIN EXPERIMENT STATION
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March 14, 1928.

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Report - District Investigative Meeting - District 5

March 12 to 14, 1928.

Approved April 30, 1928.

S. B. SHOW,
District Forester.

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March 14, 1928.

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REPORT - DISTRICT INVESTIGATIVE MEETING - DISTRICT 5.

March 12 to 14, 1928.

Sessions held at District Office - San Francisco.

Attendance

Forest Service - District Office:

S. B. Show	District Forester, Chairman.
T. D. Woodbury)	
C. E. Dunston)	Forest Management.
J. R. Berry)	
R. L. Deering)	
Jay Price)	Operation
P. P. Pitchlynn)	
J. W. Nelson)	
F. P. Cronemiller)	Grazing.
M. A. Benedict	Supervisor, Sierra.
R. W. Ayres	Plumas

California Forest Experiment Station:

E. I. Kotok	
C. L. Hill	
C. J. Kraebel	
D. Dunning	Secretary.
A. E. Wieslander	
M. R. Brundage	
H. W. Siggins	
W. C. Lowdermilk	

Office of Forest Pathology:

E. P. Meinecke
W. W. Wagener

Office of Entomology:

H. L. Person

Office of Blister Rust Control:

S. N. Wyckoff
H. R. Offord

U. S. Weather Bureau:

E. H. Bowie
L. H. Gray

Biological Survey:

F. E. Garlough

State Board of Forestry:

M. B. Pratt — State Forester.

Division of Forestry, University of California:

Walter Mulford
F. S. Baker
A. W. Sampson

Extension Forester:

Woodbridge Metcalf

Eddy Tree Breeding Station:

L. Austin

General

Ten agencies conducting research relating to forestry were invited to participate in the annual meeting of the Investigative Committee of the California District. Each agency prepared a memorandum covering its program of work, which was circulated a week in advance of the meeting. These memoranda formed the basis of discussion and are presented as separate sections of the report:

WORK OF CALIFORNIA FOREST EXPERIMENT STATION, 1927 - 1928.

GENERAL POLICY

The program submitted by the Experiment Station this year is based on the same federal appropriation secured last year. This does not permit any enlargement of the program either by increasing the scope of going projects or by undertaking new activities.

The recent consolidation with the Office of Products presents the possibility of certain limited rearrangements in projects. The Station's activities group themselves into six major categories, but all more or less closely interrelated. The basic problem, after all, is a land problem, and its corollary, "how to keep forest land productive for its highest use".

The activities of the Station must logically contribute towards the understanding and solution of this basic idea. There should be no place in the program for fundamental or even empirical research for its own sake, or for meeting some temporary exigency foreign to this basic demand.

The six major groups of work at present, in the order of time and money devoted to them last year, are:

1. Silvicultural investigations in the pine region (Management studies).

2. Forest influence studies in southern California.

3. Products and utilization studies.

4. Fire studies.

5. Economic studies.

6. Reforestation.

It becomes immediately apparent that the relative importance of the problems are not reflected in the makeup of the program, when one considers that fire, the most serious single handicap to any forest policy, still remains essentially an unmitigated threat. Again, any state or national forest policy must be dependent upon fundamental economic studies which have been relegated to a minor place in our program. It would not be an easy matter, however, to reshift the program, but care should be exercised that as new funds

are available, these be devoted to the weaker parts of the program, among which fire, economic studies, and forest influences are the more important. If we maintain the same degree of work in silvicultural investigations in the pine region, research should ordinarily be ahead of practice.

In some respects vital questions affecting national forest timber sales management have yet to be solved: i.e., natural reproduction, maintaining desirable species in the succeeding stands. There still remains considerable work to be done in arriving definitely as to the best silvicultural methods for given conditions.

There is one study grouped under economics, the preparation of a cover type map of the State, which will be exceedingly useful in fire, forest influence, management, and the economic studies.

Discussion by Committee

The Committee recognized that with present finances, no great changes in the program are desirable. It feels that the Director of the Station will not have the time to carry out the fire studies of the program and urges that another member of the staff devote part time to these studies. The Committee recommends that when increased federal funds become available, extension and intensification in fire, economic and forest influence studies, be given first consideration. This group of studies is considered of equal and paramount importance, followed by work in the redwood region and grazing studies.

Experimental Forest and Reserve Areas

The idea of establishing an experimental forest of sufficient area to support a fair sized operation under sustained yield in conjunction with an Institute of Logging has not been abandoned. If this proposal is sound, the fact that it involves a large endowment and an area larger than we are apt to associate with such an experiment, the profession should not be deterred in pushing this project forward. Recognizing the magnitude of this undertaking, other possibilities on a smaller scale must be given consideration. Of these, the Butterfly unit on the Plumas presents one of the most feasible chances for a small experimental forest. In cooperation with the Office of Management an examination was made of this unit, and it was tentatively agreed that at least a section of the virgin stand would be excluded from immediate sale and would be handled over a period of years under special treatment, particularly emphasizing varying degrees of selective logging with frequent returns, not ordinarily practiced on present going operations. This area fortunately is close enough to the ranger school to be available for demonstration purposes.

The part of the stand to be left intact as a virgin area would serve as a check plot for the going similar experiments on the area.

Two suggestions have been made for an area in the Stanislaus Center: Sections 20-21 in the Jawbone area and Sections 4 and 9, T. 1 N., R. 19 E., east of Cherry Creek near the Yosemite Park boundary.

Considerable discussion by previous committees was devoted to the selection of permanent reserve areas, classified as natural areas, and on which all use was to be excluded. A number of these areas have been tentatively selected, representing typical forest types. No actual withdrawals have yet been made and unless this is done in a very comprehensive way some of the more important areas will be lost, through sale or otherwise. These natural areas will not only be of value to foresters but equally to biologists, plant ecologists, and other scientists. It might therefore be well to consider a conference of these interested groups before a program for the District is set up.

Discussion by the Committee

Mr. Clapp's letter of January 31, 1928, and his letter of January 13, 1925, were fully discussed. Woodbury and Kotok were appointed as a committee to work out a program of experimental-demonstration forests for all of the important regions in the state. This report is to be submitted before the next meeting of the Investigative Committee. In cooperation with State Forester Pratt this committee will also consider the possibilities of a demonstration forest on second growth stands in the Sierras, on lands to be acquired by the State.

Another committee will be selected to consider the question of national reserve areas for the state. Other groups interested in this will be invited to participate.

Forestation

Nursery and Planting Experiments

An adequate and comprehensive resume of nursery and planting work in the California district has been made by Woodbury in his recent report entitled, "Summary of Planting Situation in District 5 with Recommendations for Future Work". This report covers the initiation and subsequent history of all the work so far undertaken and points out some of the difficulties inherent in the problem from the administrative viewpoint. Show, in his manuscript, "Forest Nursery and Planting Practice", which is now in process of publication, deals primarily with the research work in nursery and planting practice

conducted at Feather River and elsewhere in northern California.

In nursery practice, Show's work was confined almost wholly to the Feather River Station, the principles of which may safely be applied within reasonable limits to other parts of the pine region. As he points out, in the last analysis, each nursery site presents its own specific problems and the general rules must be tested and checked.

Since the experimental nursery practice of the California Station will also be confined for the present to the Feather River site, there will be no need for duplicating work previously completed there. Further studies will not be required at the Feather River Station on any of the following problems:

1. Amount of seed to sow.
2. Time of sowing.
3. Depth of cover.
4. Shading of seedlings and transplants.
5. Time of transplanting.
6. Kind of mulch.
7. Watering vs. cultivation.

However, additional work at this Station may be advisable on the following problems, which have been but partially studied previously:

1. Amount of water required to produce optimum root development and top-root ratios.

2. Experiments in soil improvement.

3. Kind of soil and best climatic location for the production of stock of the various species. This project can be correlated with the Eddy Tree Breeding Station nursery at Placerville and the projected nursery of the Sugar Pine Lumber Company near Northfork. It might be pointed out that nurseries in the foothill region have enjoyed a reputation for producing sturdy fruit tree stock with exceptionally good root development. The 2-0 stock produced at the Eddy nursery shows a remarkable root development. Some of this stock will be set out on the Eldorado and Stanislaus forests and will offer an opportunity for checking its adaptability to field plantings as against stock raised at higher altitudes.

Extensive experiments were carried out by Munns at the Converse Flat Nursery in southern California. Munns' material has not been assembled for final publication. Just how far the results obtained at Converse are applicable to the Devil Canyon Nursery at a much lower altitude with essentially different soil is a matter of conjecture so far. Checks should be made on such important practices as:

1. Depth of covering seed.

2. Shade requirements of seedlings and transplants.

3. Amount of water required by this soil.

4. Crown-root ratios for various species.

No records are available on the relationship of soil and air temperature to seed germination, root and top growth. Records including these data will be started this year at both nurseries.

Planting

Show has assembled in his previously mentioned manuscript the data on all of the experimental outplanting conducted in northern California. He points out, from these results, that costs in general are high and success uncertain. The greatest success with the lowest costs, has so far been attained where competing vegetation, particularly in the brushfields, has been removed and the species planted extensively. Western yellow and Jeffrey pine of 1-1 age, gave the most promise. The need for careful grading of stock on the basis of balance between crown and root development is of extreme importance. Spring planting will probably be more desirable than fall. Previous work also shows that rodent damage will continue a serious menace to the establishment of plantations. The Station, with its present personnel, can only concentrate its efforts on a few of the more outstanding problems, following up the results indicated in earlier investigations. To study further competition, a series of plantations will be established this spring on 1, 2, and 3-year old burns near Quincy. Another similar series will be started on a 1-year-old burn, continuing planting for a 5-year period so that seasonal effects may be checked. The second class of experiments will deal with planting in brushfields where the vegetation has been removed by the caterpillar tractor and drag.

Munns' work in southern California bears out in the main that the same difficulties face planting there as found in the north, but in a more intensified degree. Rodents and vegetative competition seriously hinder outplanting. Studies will first be started on 1, 2, and 3-year old burns comparable to those undertaken in the north, using mainly Coulter and western yellow pines.

Whether or not chaparral areas can be converted to woodland and high coniferous forests is a moot question, although the process appears to be going on in nature. To test this, native hardwood stock now being produced at Devil Canyon will be outplanted as soon as it is ready.

Discussion by Committee

The Committee approved the Station's program.

Cover Type Map

This major project has been carried on separately for northern and southern California. For northern California the types are mapped from the valley floor on one side and to the desert on the east and the ocean on the west. The total area requiring mapping in northern California, estimated in townships, are:

National forests	845
" parks	55

Areas outside national forests:

Sierra	290
North Coast Range	300
South Coast Range	280
Total	1,770

Work completed to date:

National forests	845	(Requiring some revision)
" parks	55	

Outside areas:

Sierra	223
North Coast Range	78
Total	1,201

A start has been made in southern California. In cooperation with the state and the administrative organization, 40 townships have been mapped, covering all of the Angeles National Forest and adjacent territory.

Future Work

At least two crews should be put in the field for the completion of the northern California work. The work in southern California, covering the other national forests and outside areas can be more expeditiously handled as a winter job.

Discussion by Committee

This project is considered of extreme importance and should be pushed forward as far as finances permit. Further help from the state and the administrative organization may be expected.

Woodbury and Wieslander were appointed a committee to iron out differences found in the data prepared for the national forests, so as to secure uniformity. The forests will be asked to revise their maps this winter.

Management Studies

Methods of Cutting (Mc-1)

Purpose

The methods of cutting studies are intended to determine the effects of management and silvicultural practices in the national forests with a view to improvement in methods of marking, logging, slash disposal and other operations. Many facts brought out by this study are also applicable to private land. The data show:

Growth rates of the important timber species under different site conditions, with varying density of residual stands following cutting.

Growth rates by size, age and tree classes within the species under varying conditions.

Distribution of mortality and damage by causes, species, size classes and tree classes.

Net growth of residual stands as affected by site, composition, density of stocking, distribution of the trees and types of trees reserved.

Relative returns from different methods of cutting in stands varying in composition and condition as determined by average value of product and average costs of production, considering growth, losses, and waste.

Progress of restocking cut-over areas through stimulation of advance reproduction and reseeding under varying conditions.

The best type of seed trees.

The frequency of seed crops and the amount and quality of seed produced.

The effects of cutting on composition of future stands.

The rate of invasion of cut-over areas by shrubs and weeds.

Methods of study

Most of the data are secured from permanent sample plots, established ordinarily just before cutting, and selected to represent typical conditions of the sale areas. A preliminary examination is made to determine the amount and condition of the original stand and the status of reproduction and secondary vegetation. Each tree 3.6 inches in diameter and over to be cut or left is measured and described to determine the character of cutting and the extent of damage resulting from logging and slash disposal. A tally of reproduction on mechanically located sample strips is made to show the amount surviving logging and changes resulting from opening up the stand. Photographs are taken from designated points for future repetition to show progressive changes. A detailed map is made showing the location of each tree marked or reserved, reproduction, brush, etc.

After logging is completed the remaining trees are given permanent numbers, the diameters, total heights, and length of crowns are measured and a detailed description is made of each tree, showing condition of crowns and boles, the amount of seed borne, etc. The map is revised to show the parts of the area covered by skidding trails, areas of destroyed seedlings, location of slash piles, and areas covered by slash fires. The reproduction strips are re-examined, in some cases each seedling being numbered, mapped and measured. The photographs are repeated. In some cases the plots, or portions of them, are fenced to avoid disturbance by grazing or other use.

Subsequent complete examinations are made at 5-year intervals. The seedling sample strips are usually re-examined annually, and seed crop records are obtained by counting the cones on a portion of the numbered trees.

Besides records from the permanent sample plots, information on growth is secured from older cuttings, both government and private, by means of increment borings. These are used to supplement the above records in predicting volumes available for a second cut in management plans. Records kept for all sales by the forests are also used. In 1921 and 1922 special examinations were made of practically all the important private operations in the state.

Present status

This study was begun in 1910, about five years after the first Forest Service sale was made in California. Four plots were established in 1910, ten in 1911, eight in 1913-14, two in 1922, one in 1923, and three in 1927. These plots vary in size from 6 to 160 acres, aggregating about 473 acres, with 22,879 numbered trees. A

summary of the twenty-eight plots now under observation is given in the following tabulation:

Summary of Methods of Cutting Plots

Forest	Plot	Date established	Area acres	Site	Type	Board feet per acre	Per cent of volume left	Number of trees
Lassen	1	1922	10.0	III	WYP-JP	3260	15.1	139
"	2	"	10.0	III	"	2240	11.9	123
"	3	1927	10.0	IV	WYP-WF	7700	31.5	972
Plumas	1	1911	24.0	III	WYP	11220	47.5	1550
" F.R.	1	1914	6.4	II	Mixed	18200	45.1	495
"	2	"	6.4	"	"	26300	48.5	492
"	3	1913	6.4	"	"	14300	27.5	533
"	4	"	6.4	"	"	23200	40.5	552
"	5	1914	6.4	"	"	14900	28.2	438
"	6	"	6.4	"	"	15000	27.5	416
"	7	1913	6.4	"	"	22600	40.8	507
"	8	"	6.4	"	"	25300	34.5	534
Sequoia	1	1911	10.0	I	SP-WF			1158
"	3	"	10.0	II	WYP			913
"	4	"	10.0	I	SP-WYP	21550	48.4	1617
"	5	"	10.0	"	WYP-SP			707
"	6	"	10.0	"	WYP			716
Shasta	6	1911	25.0	III	WYP	9900		1516
"	11	"	10.9	III	WYP	6340		934
Sierra	1	1911	6.0	I	WYP	12830	28.2	585
Stanislaus	1	1910	20.0	I	SP-WF			2070
"	2	"	20.0	"	SP-WYP			1222
"	3	"	20.0	"	SP-WYP			1061
"	4	"	20.0	"	SP-WYP-WF			1289
"	5	1923	10.0	"	SP-WYP-WF			472
"	6	1927	15.5	"	SP-WYP-WF			1242
"	7	1927	160.0	"	SP-WYP-WF			Not numbered
Tahoe	3	1911	20.0	III	JP-WF	16000	38.0	629
Total			473.1					22879

Fourteen of the plots have been under observation for three 5-year periods and eight of them for two periods. The results have been effective through revisions of marking and logging regulations. The importance of preserving advance reproduction and difficulties of securing satisfactory restocking have been emphasized. It has been shown that leaving large valuable pines to increase the proportion of these species in the next stand has not had an effect commensurate with the risk of loss involved and reduction of average growth rates through exclusion or suppression of thriftier classes of trees. The primary causes of damage

in logging have been brought out through these studies, and especially through the specific studies of logging damage conducted by the Office of Forest Management. These facts, and the recognized greater economy of tractor logging, have been influential in restricting donkey logging on sales to rough areas impracticable for tractor or other less destructive logging methods. The growth data have been used to forecast yields in management plans.

From the records of the individual trees on these plots a tree classification has been formulated for application to the all-aged, irregularly stocked, mixed stands concerned. This classification is used to segregate individual trees according to vigor and seed bearing capacity in marking, sales inspection and insect control, studies.

Information secured in this study has been used in the preparation of several publications such as Dept. Bul. 1402, "Timber growing and logging practice in the California pine region"; Dept. Bul. 1176, "Some results of cutting in the Sierra forests of Californis"; and periodical articles, such as "Relation of crown size and shape to rate of growth and response to cutting in western yellow pine", "Predicting the second cut in national forest management plans", and "A tree classification for the selection forests of the Sierra Nevada".

Work during 1927

Three new sample plots were established during the field season of 1927. The 10-acre plot on the Lassen (Fruit Grower's Supply Company sale) utilize the same area on which the Office of Forest Management conducted a study of tractor logging in 1926. It is in the western yellow pine - white fir type, containing some sugar pine and incense cedar. The site class is probably IV. The method of cutting represented conforms to the sustained yield provisions of the management plan for eastern Lassen working circle, reserving a considerable portion of the stand for a second cut. The second plot of 15.5 acres was in the sugar pine - western yellow pine - white fir type, Site I, on the Stanislaus Forest (Pickering Lumber Company sale). This plot was also utilized by the Office of Forest Management in studying tractor logging under these conditions. The forest school at the University of California cooperated in making a time study of tractor logging. Marking was done by a marking board during a conference on the Stanislaus in May. In addition to the usual data secured each tree was log graded and the logs numbered to correlate cost of logging and grades produced for different classes of trees, and to determine the relative values as well as volumes cut and left on the area. The report on the logging damage phases of this study has been completed by Berry and Hughes of the District Office.

The third plot was located on the old Miner's Ditch sale area, Stanislaus, adjacent to the plot at Cow Creek. It comprises 160 acres similar in type, site and method of cutting to the Cow Creek plot. Its purpose is to provide more reliable records of losses after lumbering than the smaller plots yield. Stand tables were constructed by a 10 per cent cruise of the surviving timber. All dead trees were tallied by site, species, tree class and cause of death, and were marked to distinguish

them from trees which die later. Growth figures obtained from the Cow Creek plot will be applied to the stand tables to determine the relation of losses to growth.

The Stanislaus plot at Cow Creek (Plot 5) was fenced, the Experiment Station supplying the material and the Office of Blister Rust Control furnishing the labor. The Office of Blister Rust Control is using this area to study the effects of cutting on Ribes invasion.

Seed crop counts were continued for the numbered trees on several of the plots.

In connection with the proposed experimental forest at Feather River field station a survey was made of the Butterfly unit, four sections being covered intensively by a type and site map. Each 5-acre unit was classified according to suitability for different kinds of cutting plots. Section 21 proved to be most suitable for sample plots of various kinds and is also suitable for a demonstration area for the District training school and the University Forest School. It has been decided to reserve Section 21 from the major sale, making special small sales to care for experimental cuttings as necessary. The exact location of these sales will be decided next spring by agreement with Forest Management and the Plumas.

The possibility of reserving some virgin tracts for future experimental cuttings or control areas was discussed with Mr. Clapp and Mr. Munns during the summer. The Butterfly (Plumas), Strawberry and Jawbone (Stanislaus) areas were visited with this in mind. Except in the case of Butterfly Valley, no definite areas have yet been selected. It is planned to examine the Cherry Valley area (Stanislaus) in the spring.

Marking conferences of Washington, District and Forest officers were attended on the Stanislaus and Crater Forests during the season.

Conferences were also held with Miller, Person, and Keen of the Bureau of Entomology in regard to the classification of trees for insect studies and experimental marking to reduce insect losses on sale areas.

Compilation of the results of sample plot measurements has fallen considerably behind due to lack of assistance prior to 1926, efforts being directed toward keeping the current field measurements up to date. With additional funds provided through establishment of the Experiment Station, this compilation work has progressed more rapidly. All of the original and remeasurement records have been worked over to eliminate differences in methods and discrepancies brought out by later examinations. Practically all the older plots are now up to date. One of the plots established this season has also been completed and work has begun on the other two.

Future plans

As yet the field plots do not well represent the more important combinations of site, type, and methods of cutting. In accordance with original plans new plots are to be established from time to time as suitable areas are approached by cutting, dependent of course on the exigencies of the Station program as a whole.

Improvement in the conduct of field and office work has greatly reduced the time and expense of carrying this study. Elimination of excessive travel by concentrating the field plots in a few centers of work and timing establishment to avoid piling up of work during certain years makes it possible to handle the study more efficiently. Some of the plots of lesser value are now treated less intensively than formerly without impairing their value or abandoning the investment which has accumulated in them through the lapse of time. Even with these precautions it is necessary to exercise care to prevent improper balance in the Station program.

It was found necessary again to defer establishment of a plot in the sugar pine - fir type, although the study of reproduction in this type was begun. Cutting on the Pickering sale did not reach suitable areas in this type during the season, but since it will do so next season within the Stanislaus center of work, it was thought inadvisable to select an area far removed from other work, as would have been necessary. A plot will probably be located along the north fork of the Tuolumne River this spring.

Establishment of a new plot in pure western yellow pine of poor quality where insect losses are heavy was also deferred. The Bureau of Entomology has established three such plots on one of which cutting was to have been done last fall. It now seems doubtful whether this cutting will materialize in time to be of most value. Some cutting will doubtless be possible next season in the Modoc region, where two of the insect control studies are located. It seems best to combine efforts with the Bureau of Entomology rather than to duplicate this work elsewhere.

There seem to be good prospects of an opportunity to make a thorough analysis of cutting in mixed pine and fir stands applicable to both private and national forest operations. Hitherto it has been impossible completely to correlate costs of production and grades of lumber produced with different classes of trees. It would be of great value in appraisals to have log grades and millscale studies tied in to the same trees. The data secured would go a long way toward indicating the most economical type of cutting in stands of varying density, trees of different sizes and classes, and stands of varying composition, particularly as regards stands or mixtures of white fir and incense cedar.

Through possible cooperation with the Pickering Lumber Company on the Stanislaus, such a study of logging and milling costs and grades could be made on the same trees. It would be necessary to conduct part

ofthe study on private land to get data on small trees without modification of present methods. If such a study materializes cooperation with Forest Management would be necessary.

The above mentioned sugar pine - fir plot is planned for the same general area and should be made a part of this experiment if possible.

The proposed western yellow pine plot of poor site quality will be followed up again this season as discussed above.

Possible cutting in the Butterfly area on the Plumas may result in the establishment of one or more plots there.

The recutting of parts of the four older Stanislaus plots was discussed in last year's program. If logging progresses in such a way as to make it possible, this cutting will be done this season. It is hoped that the Forest School may cooperate here in a study of changes in tree form resulting from the first cutting in 1910.

This cutting may offer a good opportunity for a study of decay induced by logging damage contemplated by the Office of Forest Pathology.

The eight plots at Massack (Plumas) and the Cow Creek plot (Stanislaus) are due for reexamination this season.

Compilation of previous records for all plots will be completed before the field season begins. It is hoped the bulletin summarizing results thus far will also be completed.

Discussion by Committee

General program proposed by the Station approved. If the Pickering Lumber Company fails to cooperate, this year, another company should be solicited next year.

Natural Reproduction (Mr)

Purpose

The system of management in effect on the national forests is completely dependent upon successful natural regeneration. A thorough knowledge of the factors controlling reproduction is therefore essential. Although the importance of such a study has long been recognized, the complexity of the fundamental problem involved has prevented satisfactory progress with available facilities and personnel. Close continuous observation and instrumental records, both in the field and under controlled conditions, are necessary.

While the majority of sale areas are satisfactorily stocked with young trees, most of the seedlings were established prior to logging. The effects of different methods of cutting on the establishment of subsequent reproduction are obscure. The conditions under which advance reproduction was established are not well known. What methods of cutting are necessary in the various types under different site conditions to insure adequate restocking remain to be determined.

Present status

A few early empirical studies were begun on the forests covering certain phases of natural reproduction. Some of these were abandoned before results of any value were obtained. A considerable amount of valuable information on quality of seed and conditions for germination and survival was obtained from nursery and planting experiments at Converse, Pilgrim Creek, and Feather River nurseries before these were abandoned in 1917. Plots were established on the Eldorado to follow rate of restocking after logging and fire. Another series of plots are located on the Stanislaus to determine the effect of bear clover on reproduction. The methods of cutting plots have yielded valuable information on rate of restocking and survival of advance reproduction, but have not been followed closely enough to determine causes of what has happened. There are inventory strips or subplots on all the methods of cutting areas. On the Plumas a series of eight chain-square plots are fenced and each seedling is measured and mapped together with other permanent vegetation. General notes on seed bearing are made for each tree on these plots and on certain trees actual counts of cones are made annually.

Work in 1927

On the fenced plot at Cow Creek (Stanislaus) two strips 10 chains long and 0.1 chain wide were carefully staked out and mapped, each seedling being numbered and measured. In addition 6 sets of 3 quadrats each were established to determine the effect of removal of cover, competition with seed trees and control of rodents. In each set one quadrat is screened to exclude rodents and wild seed and to catch the wild seed falling on the plot. Under these screens known quantities of seed were sown in the fall. The second quadrat in each set is screened against rodents but permits entry of wild seed. The third quadrat is an unscreened control.

Cone counts were again repeated on the numbered trees.

A small amount of work was done by Tyler at Feather River to determine the amount of competition for soil moisture in the neighborhood of large seed trees.

Future plans

Work on this project is to be expanded as rapidly as possible.

If the screens placed this fall successfully withstand snow loads and keep out rodents, more such quadrats will be established.

Seed crop counts will be continued.

A study of root competition between seedlings and large trees left after cutting will be begun on the Stanislaus. The root relations will be investigated by washing away the soil. Attempts will be made to release suppressed advance growth by severing the competing roots of larger trees without changing the light relations.

Discussion by Committee

The Committee approved the program submitted.

Thinning (Mt-2, 101, 161, and 167)

Purpose

Although thinnings in second growth stands are impracticable at present, the long time necessary for experiments to produce conclusive results justifies starting such work now. No information applying to native species exists to show what spacing at different ages on different sites will produce the largest volume of the quality of timber desired, or what method of thinning will give these results for the several important species. Should thinning be heavy or light? In the upper or lower crown classes? At what age should the first thinning be done, and how often repeated? Can these intermediate cuttings produce the desired yields and at the same time be adjusted to market requirements in such a manner as to pay for the operations?

Present status

There are now 22 permanent sample plots under observation in even-aged stands of second growth. The character of these plots is indicated by the following summary:

Summary of Thinning Plots

Location	Plot	Type	Age	Site	Area acres	Number trees	Date established	Thinning method
Klamath	1	DF	50	II	1.00	295	Fall 1912	Moderate
"	2	"	50	"	1.00	609	"	Control
Feather River	1	WYP	53	II	0.45	593	Sept.1919	German-moderate
" "	2	"	43	"	0.44	585	"	Control
" "	3	"	56	"	0.41	210	"	German-moderate
" "	4	"	56	"	0.55	233	"	Control
" "	5	"	28	III	0.23	1437	"	Control
" "	6	"	28	"	0.29	358	"	German-light
" "	7	"	28	"	0.39	446	"	German-heavy
" "	8	"	28	"	0.34	511	"	German-moderate
Quincy Jct.	A	"	43	"	0.51	311	May,1920	German-moderate
" "	B	"	"	"	0.37	254	"	French-from below
" "	C	"	"	"	0.43	258	"	Cotta
" "	D	"	"	"	0.45	396	"	Control
" "	E	"	"	"	0.55	463	"	Control
" "	F	"	"	"	0.33	150	"	Borrgreve
Stanislaus	1	SP-WF	52	I	0.66	384	June,1921	Moderate-from below
"	2	" "	"	"	0.40	451	"	Control
Westwood Jct.	1	WF	75	III	0.25	140	Sept.1927	Moderate-from below
" "	2	"	"	"	0.25	211	"	Borrgreve
" "	3	"	"	"	0.25	68	"	Danish
" "	4	"	"	"	0.19	218	"	Control

Fourteen of the plots are in pure western yellow pine, four in white fir, two in Douglas fir, and two in mixed stands of sugar pine and white fir.

The Klamath Douglas fir plots have been remeasured three times at approximately 5-year intervals. Two progress reports have been prepared. The Feather River, Quincy Junction, and Stanislaus plots have been remeasured once and progress reports are being prepared.

Work in 1927

The Klamath plots were remeasured this fall.

Four new plots were established in pure white fir, Site III, on the north slope of Peg Leg Mountain (Lassen). One of these was thinned from below, removing all suppressed trees, practically all the intermediates and some of the codominats. The second plot was thinned from above, removing the dominants, to approximate the type of cutting that will probably first become economically feasible, and to see whether understory trees at this age can be stimulated to produce profitable growth. The third plot was thinned heavily with the idea of securing

good spacing and preserving only the best formed trees for the final stand. Most of the trees reserved are dominants, though some trees of other crown classes were left where no suitable dominants were present. The fourth plot was left in its original condition for control.

Compilation work was begun on the records from the new plots.

Future work

This project will not be greatly amplified for some time. As funds are available it should be extended to cover the range of important variables. A few plots in younger stands should be established, since these are relatively inexpensive.

Compilation of all plot records will be completed as rapidly as possible and progress reports prepared.

Discussion by Committee

The Committee approved the program submitted.

Mensuration

Growth and Yield

Three methods of securing growth data for yield forecasts are being followed:

1. Temporary yield plots are measured in even-aged, fully stocked second growth stands of different age classes, site qualities, and type mixtures. From these plots normal yield tables are constructed.

2. The history of development of similar stands is being followed by means of permanent plots with the same ultimate object.

3. For all-aged mixed stands average growth rates for trees of different sizes are obtained from the permanent methods of cutting plots described above, and from old cut-over areas by use of the increment borer.

These growth rates are applied to stand tables to forecast the probable amount of the second cut.

Temporary Yield Plots (ME-4 and ME-101)

Approximately 655 temporary yield plots have been measured. They average about one-fifth of an acre in size. Of these, 133 were measured in pure western yellow pine under west slope conditions, 175 were in western yellow pine and white fir on the eastern Lassen, and

347 were in mixed stands on the west slope of the Sierra.

Yield tables have been prepared for western yellow pine under optimum conditions on the west slope and on the east side. For the mixed stands the number of plots is still insufficient to represent the principal type, site and age class combinations. Further search last season did not discover any new areas of promising second growth.

The Forest School at the University of California has cooperated in this study. Yield tables have been completed for pure white fir stands and tables for red fir and Douglas fir are in course of preparation.

Considerable work has been done to establish a basis for discounting normal yield tables in application to understocked average stands.

Future work will be directed towards determining methods of applying normal yield tables to average stands. New plots in mixed stands will be measured whenever areas representing additional variables can be found. All the data for pure western yellow pine are to be worked over into a yield table by standard procedure, the two tables mentioned above being based on different volume tables and different site classifications. This work must be adapted to the larger study of yields for the whole range of western yellow pine.

Permanent Yield Plots (ME-101, 161 and 167)

The present series of permanent yield plots in second growth stands consists of one on the Plumas in 50-year western yellow pine, Site II; one on the Shasta in 35-year western yellow pine, Site II; one in pure Douglas fir, 50 years old, on the Tahoe, Site II; and one in pure white fir, 75 years old, on the Stanislaus, Site I. In addition there are five thinning control plots in pure western yellow pine on the Plumas, one in Douglas fir on the Klamath, one in white fir on the Lassen, and one in sugar pine - white fir on the Stanislaus. These plots are measured at 5-year intervals. First progress reports have been prepared for the Plumas and Shasta plots. No work was done on this project last season except for the establishment of the white fir plot on the Lassen as mentioned above.

As suitable stands are located additional plots should be established from time to time. Some plots are needed in young understocked stands to determine the progress towards normality with increasing age.

Growth Prediction in Selection Stands

This work has been carried under the methods of cutting project. A preliminary set of diameter and height prediction curves for the five important species and first three site classes were prepared from the sample plot records. Revised curves for western yellow pine, sugar pine and white fir, Site I, have been prepared from increment borings on old cuttings. Similar curves for Site III western yellow pine have also been completed. Considerable further data have been gathered by men on the forests during preparation of management plans. No additional work was done this season except to review some data for the Sierra working plan.

All material is now being brought together in form available for management plan use.

Future plans include completion of the series of prediction curves by examinations of old cuttings. Data must be accumulated also on mortality and other factors which affect discounting stand tables. The results of such predictions should be checked against actual growth of several of the older sample plots.

The validity of this method of predicting growth is open to question at certain points. It is being used because no better method has been advanced. One point in question is whether growth in various parts of the stem is proportional to growth at breast height. Some work done in the Southwest and in Sweden indicates that errors which might result from this cause are within the limits of possible accuracy of the other factors concerned. The possibility of a second cut on the two Stanislaus plots mentioned above, may offer a chance to work out this point. The Forest School is desirous of securing the necessary measurements if this chance materializes.

Discussion by Committee

The program submitted by the Station was approved by the Committee. There is need for a statement of yields in second growth western yellow pine on the west slope of the Sierras. This will be prepared at an early date from data already available.

Root Investigations

The work on roots is an outgrowth of the study of stocking in even-aged stands and has not been given project status. The original object was to determine whether there is a usable relationship between the area of soil occupied by the roots, the area of the crown and basal area of the stem. The importance of this study in relation to natural reproduction, effect of fires and erosion, justifies making it a separate project.

Very little is known about the roots of forest trees, either here or elsewhere, primarily because of the difficulties of study. This is practically a virgin field for original research. Silviculture is very largely based on behavior of the visible portions of the tree, or crown. That the root system is equally as important as the crown is rapidly coming to be recognized.

In this country Weaver, Cannon, Cooper, Clements, and McDougall of the Carnegie Institute have done extensive work on herbaceous species and something on shrubs and trees. Similar work has been done by Sampson on herbaceous species. Moore and Burns have worked on seedling forest trees in the Northeast. Boerker did some greenhouse work on western species a number of years ago. Haasis did some work on western yellow pine seedlings in the Southwest. A few other small studies are known to have been made. Practically nothing has been done on large trees under natural conditions.

In Finland, Aaltonen and others investigated the roots of forest trees during studies of natural reproduction. In Sweden, Hesselman studied seedling roots during investigations of the humus layers. Some studies have been conducted by Engler in Switzerland, and some also in Russia.

Work on many phases of root studies has been done in Germany by a large number of foresters. It is at present a subject of active interest there. Some of the later research deals to a limited extent with older trees of Scotch pine, spruce, larch, etc., but seedlings have received most attention because of the labor necessary in excavating larger root systems.

Practically all relationships studied are still inadequately known. The labor of digging is principally responsible for this because it prevents study of large numbers of individuals under different conditions.

The work so far done by this Station has been preliminary in character intended to determine proper methods of excavation and what phases of the study should be attacked first. A fully stocked stand of pure western yellow pine 53 years old on the Stanislaus was selected for study last May. The largest trees are 12 to 14 inches in diameter and about 55 to 60 feet high. An area one chain square was mapped to show the location of all trees and their crown projections.

The area was on a slope about 135 feet above the Tuolumne River. The soil was deep, the upper 20 inches an alluvial deposit derived from andesite overlaying a granodiorite base. Water under pressure delivered by fire pumps was used in excavation.

A cross-section of the area, selected to intercept trees of the different crown classes, was dissected vertically through the strata

occupied by the roots. Dissection was then extended horizontally to the depth where most of the roots occur. The principal roots were mapped and detailed photographs were taken as the work proceeded. The needles were stripped from trees of different crown classes and weighed with a view to working out a leaf area relationship.

The principal facts brought out are as follows:

The area occupied by the roots extends far beyond the area of the crown projection. The direction of spread bears little relation to the crown projection but is determined primarily by competition with other trees which modifies the innate tendency to spread radially from the axis. The direction of main laterals is more closely influenced by competition than by need for mechanical support.

The root tips active in absorption during the growing season are mostly very close to the surface - from 1/2 inch to 6 inches beneath the litter. The main mass of conducting roots are 6 to 14 inches from the surface. Burning, removal of litter, trampling, etc., must have an immediate effect on growth.

There is no tendency for the feeding laterals to penetrate deeper and deeper with age. The depth at which most of the laterals occur is attained by seedlings during the first few years, after which trees of all age classes are competing in the same narrow soil layers. Increased feeding area is obtained primarily by growth in the horizontal plane. Soil depth is probably not as important as supposed in determining length of rotation.

Branching takes place normally in portions of the root less than one year old. Adventitious roots are not normally formed in this species. The soil is worked over in successive zones from the stem outward and partially abandoned in the same order. As the soil near the tree becomes in time more fertile again, the tree itself can not normally put out new rootlets to reoccupy it. The area immediately surrounding the trunk is invaded by the roots of neighbors of the same age or of seedlings. Competition is keenest some distance from the trunk. Seedlings grow better immediately adjacent to the older trees than a few feet distant.

Western yellow pine, in common with many other xerophytes, has a dual root system. When the upper soil is moist the main system of laterals supplies the tree with material for active growth. The tree tides over periods of drought by a main tap root and a number of auxiliary tap roots, or sinkers, which descend from the main laterals vertically to permanently moist soil at an undetermined depth.

There is much grafting or fusing together of roots. Whether these grafts are actively functional in this species is unknown. If they are, there is the possibility that weaker trees may be partially sustained by stronger ones.

The hydraulic method of excavation offers excellent possibilities for extensive investigation of tree roots at fairly reasonable cost.

Future plans

A large number of important relations for research are suggested by the preliminary work, few of which can be considered at present.

It is suggested that work be continued on the area relation for one species, one age class and one type of soil in a stand old enough to show good differentiation into crown classes, but small enough so a considerable number of individuals can be excavated.

Some work should be commenced on the relation between the roots of seedlings and reserved seed trees on sale areas where seedlings show little effect of release by cutting. Similar relations between brush and seedlings should be studied.

Profitable work could be done in southern California in determining characteristic types of root systems of the important shrubs in relation to soil holding capacity, fire resistance, etc.

Fire Studies

Meteorological Conditions and Fire Hazards (RS, Pf, B-1 and B-5)

This is a continuing project in cooperation with the Office of Operation and the Weather Bureau, which provides for the collection of essential weather records at key stations throughout the State. With the assignment of Mr. Gray, of the Weather Bureau, this work is being conducted almost entirely by the Weather Bureau, and it is assumed that the work proposed for the future will be discussed by the Weather Bureau at this conference.

Fire Damage (RS, Pf, A-1)

A series of plots previously established on which the effects of fires on different tree species and age classes have regularly been followed for a number of years. This should be continued for at least a 5-year period so that the ultimate effects can be reasonably well ascertained.

On the California National Forest one plot was burned over in 1920 to study particularly the effect of a series of summer fires on vegetative succession in the lower timber limits bordering oak and chaparral brushfields. Annual examinations have been made of this area, but no repeated burns have been carried out. The experiment already clearly indicates the process that takes place when fires occur

on the borderland of brushfields and timber. The evidence shows that the timber is pushed back and that brushfields take its place. It would be a mistake to burn this area for at least another 3-year period, until this process has stabilized and the new invasion of conifers begins to show up. This will simulate more nearly what has taken place over much of the foothills in California.

Controlled Burning on the Permanent Light Burning Plot on the Plumas National Forest (RS, Pf, C-3)

This area of 200 acres was first burned in 1919 and has been reburned four times during the ensuing 8-year period. A burn was attempted practically every year during the life of the experiment, but could not be accomplished because of unfavorable climatic conditions. This experiment attempted to test whether annual light burning could ever be successfully carried on within the timber belt proper in a virgin forest; and to determine the ultimate effect of such treatment. The results conclusively prove that not only was it impossible to light burn annually, but that in no instance was it feasible to burn over the entire area. If south slopes burn as desired, the north slopes fail to carry fire even if applied in the most intensive manner with Hauck torches. Where fire burns the litter the inevitable complete destruction of new seedlings and the damage to older reproduction may be expected. The last burning in 1927 continued to reduce the stand by undercutting of scarred trees in almost the same degree as in the previous fires. Whether the continuation of this experiment will add further data of consequence is doubtful, and it is recommended that the experiment be closed and the results to date be compiled and published.

Statistical Studies of Fires, 1921-1926.

The material for this study, including about 9000 fires and about 42 items for each fire, has been assembled and preliminary tables made. Show and Kotok will, if time permits, prepare a manuscript for publication during this spring.

The same material for fires for southern California from 1911 to 1926 has been assembled and punched on special tabulating cards. Preliminary tables are being prepared and the manuscript will be completed next winter.

Other Studies

Last year we listed four new fire studies: Study of going fires; a study of foothill fires in northern California, and the Sierras; a study of fire lines; and a study of the effectiveness of fire-fighting equipment. Excepting for the latter no work was possible. It must be recognized that in attempting to study going fires the investigator is left to the mercy of chance whether he can reach desirable fires with equipment in time to proceed with his investigations. Last

year was a favorable fire season and the opportunities were rather few for the conduct of this work. Another difficulty is that the investigator can not be carrying on any other regular work and expept to be able to accommodate himself to the whims of fires. To overcome these obstacles it is proposed to place a crew on some effective work within the Plumas Forest but ready and able to proceed without delay to any adjacent going fire on the Plumas or Tahoe, irrespective of reported size. In this way it is hoped that at least three fires may be examined. Only three of these studies will be undertaken this year, namely, study of going fires, study of fire line and fire breaks, and study of fire fighting equipment. The latter study will be handled by operation, the Experiment Station making checks only. The study of foothill fires will be omitted because of an unusually crowded program.

Discussion by Committee

The program of the Station was approved by the Committee.

Southern California Work

Cooperative funds from the State, the counties and municipalities have made possible much further extension of our program here than the original federal allotment permitted.

The general interest of the public and the cooperative agencies has been in forest planting, and in the conversion of the brushfields into high coniferous forests. The Station considers this problem as of minor importance when compared to the more vital questions of run-off and erosion and their possible control. It has been no easy task to orient public interest in the right direction. The Devil Canyon nursery in part supplies the public urge for planting and gives us at the same time an opportunity for further studies in planting and nursery practice in this region. (The nursery and planting work we have begun is covered in the chapter on reforestation.)

Our major effort, however, has been placed in the Forest Influence studies and as funds increase our attack will be accordingly enlarged. The following phases have been started:

Erosion and Run-off (Barranca Watershed)

Our first study is devoted principally to the development of technique and methods in measuring erosion and run-off from watersheds.

The measurement of the normal flow of rivers and of controlled irrigation waters has reached a high degree of accuracy. But a satisfactory method for measuring torrential run-off waters charged with heavy burdens of eroded material has not yet been developed. Such a method must be evolved before we are prepared to undertake the measurement of run-off from comparable forested and denuded watersheds in

southern California.

The Barranca Burn of 1925, a 60-acre watershed near the mouth of Devil Canyon, offered an opportunity last summer for initial attack on this problem within the limits of available funds. During the summer, instruments and works were installed to measure for the entire watershed - the amount and intensity of rainfall, the amount and rate of run-off, and the quantity of eroded material.

The results of the first storm to produce run-off indicated that the methods used for measuring rainfall and sediments are satisfactory but that the method for obtaining the run-off is not suitable for the conditions. The measurement of run-off was tried at the mouth of the canyon by means of a weir and water stage recorder, the water passing thereafter into a large reservoir for settling of the sediments. Either a different method must be devised for measuring the sediment-burdened water or the water must be relieved of its burden before measuring. The latter method was early contemplated but could not be tried last year because of its comparatively high cost. It calls for the waterproofing of the catchment reservoir with concrete or otherwise, and installation of the weir in the dam itself. The question for advisement is whether it will pay to do this even yet at the Barranca study as a test before applying it to the ultimate study of comparable watershed.

To observe the natural process of erosion control on burned-over areas by vegetative cover, permanent sample plots have been established in various types of cover, slope and aspect throughout the Barranca Burn and in adjacent unburned area. Spring and fall examinations of these plots will probably be necessary to follow in detail the vegetative development of different species and their effect upon erosion and soil formation. This type of work should furnish a key to the interpretation of some of the data gathered on a large scale by the cover type inventory.

During this year a detailed study of the soil and parent rocks of the area, and of the changes which take place after burning, is felt to be important. In this work we should secure the cooperation of soil experts of the University and of the Federal Bureau of Soils.

Similarly, with respect to the rodent and other faunal population, we should secure the assignment, at least temporarily, of a qualified biologist. That fire in the chaparral region is followed first by the practical elimination of the rodent population, and later (with increase of harbaceous growth) by an increase over the normal pre-fire population, seems true. This situation calls for scientific inquiry to establish the interrelationships between rodent life and the vegetative recovery in burns.

Intensive Run-off and Erosion Plots

In addition to the large-scale study of the Barranca Burn, special small areas have been selected for intensive study of superficial run-off and erosion on burned and unburned chaparral covered slopes.

Two pairs of plots, each 20 x 50 feet in extent, equipped with tipping bucket instruments for measuring and recording both the quantity and rate of superficial run-off and the quantity and intensity of rainfall simultaneously, were installed in cooperation with W. C. Lowdermilk. To date, records have been obtained for one storm of 3.34 inches of rainfall, the results of which are strikingly similar to those yielded by similar studies in China. Further detailed laboratory studies of superficial run-off on soils of diferent origin with varying degree of humus content are being made at the University, which will give additional valuable data. Special equipment was designed for this study by Lowdermilk.

Proposed work

In the course of the year search will be made for two or more pairs of similar chaparral covered watersheds upwards of ten acres in area, which have been untouched by fire for at least twenty-five years, and which will otherwise meet the exacting requirements of a comprehensive rainfall - runoff - erosion study. The possibility of cooperation by the Los Angeles County Flood Control Commission in this study is suggested by their interest in the work at Barranca Burn. In addition to this long-time study, involving a large expenditure of funds, careful consideration should be given to the desirability of establishing intensive superficial run-off plots of the Lowdermilk type in various cover types throughout the chaparral region. These can yield immediate information of considerable value.

Water Use

A statistical study of the sources and total amounts of water used in southern California and the relations between total rainfall, total use, and present total unused run-off; and the possibilities of increasing the available supply by conservation methods such as storage, retardation of run-off, refinement of use, etc. This study will require cooperation with the U. S. Weather Bureau, Geological Survey, State and County Engineers, irrigation and power companies, flood control organizations, etc.

Beginning in 1915, under a cooperative agreement between the County of Los Angeles, the Geological Survey, the American Society of Civil Engineers, the Weather Bureau and the Forest Service, experimental data have been collected on precipitation, streamflow, the effectiveness of check dams, etc. There is a wealth of unassembled material bearing on this entire question which should be correlated

and applied as a background for any major water conservation study. It is proposed to assign one man to collect this material.

Climatological Observations

The establishment of permanent meteorological stations at strategic places throughout the chaparral region for the accumulation of dependable, complete and continuous weather records is urgently needed. Such records are essential in all the other groups of studies, and are not obtainable in any other way.

The greatest difficulty in establishing such stations is to secure observers who are themselves permanent and dependable. Perhaps the solution lies in cooperation with other agencies which have use for the same data, namely the Weather Bureau, power companies, water companies, cities drawing their supplies from mountain watersheds, state and federal hydrographic bureaus, etc. All such agencies pooling their interest in this matter could command the State of California with a set of master climatological stations which would be unique in the world for completeness and scientific value. One of the chief drawbacks to the use of the vast amount of existing streamflow data for a statistical study of forest influences is the woeful lack of rainfall records for most of the watershed areas represented by the streamflow records. But in addition to precipitation the records most needed are those of temperature, humidity and wind.

We have established one meteorological station at Devil Canyon Nursery, its location having been chosen with the advice of the Weather Bureau. A second station is planned for the Santa Barbara region from funds contributed by the city of Santa Barbara. Other stations will be established as funds and observers become available.

Discussion by Committee

The Committee approved the program.

Phenological Studies

The Committee discussed at length the advisability of initiating a district-wide phenological study. The value of such studies was not questioned but considerable doubt was raised as to whether the administrative organization could furnish consistent and reliable data. It was brought out that for years we had been collecting such material and no use had been made of it. The Committee suggested that before starting again study be made of existing data.

RESEARCH BY THE ADMINISTRATIVE ORGANIZATION

Continued effort will be made to extend research work by the field organization as outlined in previous reports. Some progress has been reported, but much more may be expected in the near future.

Projects Reported on

Stanislaus - Slash Burning Study

The object of the study was to determine the relative damage done by burning slash piles with limbs four inches in diameter and without limbs of the same diameter. The study was started in 1926 on the Herring Creek sale in the mixed conifer type. The stand averaged 40 M.B.M., of which about 32 M.B.M. was cut. Reproduction was above the average for the region. The results indicate that damage to reproduction is insignificant beyond 10 feet from the edge of the pile, regardless whether large limbs are included or excluded. Within the first ten feet of the edges of the brush piles, the amount of reproduction killed varies from 0.7 per cent for the piles without large limbs to 2.8 per cent for the piles with the 4-inch limbs included.

Lassen - Slash Burning Study

The object of the study was to determine the amount of damage to reproduction from burning slash piles with and without limbwood. The study was carried out on the Fruit Growers Sale in a pure western yellow pine type. The results indicate a decided difference in behavior of fire in the two methods of piling. Where limbwood is included, the pile is fully in flame on an average in 20 minutes, ceases to flame in 44 minutes, but holds fire about 8 hours. Where limbwood is excluded the pile is fully in flame in 28 minutes, ceases to flame in 45 minutes, and holds fire for 63 minutes. With limbwood in the pile the percentage of reproduction killed is consistently higher than with limbwood excluded; at 7 feet from the edge of the pile the difference is 15 per cent. Without limbwood, damage ceases at 9 feet, while with limbwood it continues up to 15 feet.

Santa Barbara - Grazing Damage to Reproduction

This study was started in 1926 and aims to determine the amount of damage resulting from grazing in the pure western yellow pine type of southern California. The results have not yet been reported.

New Studies Proposed

Lassen

Logging damage study where snaking wheels are used.

Eldorado

Reforestation study in cooperation with Eddy Tree Breeding Station, using their stock.

Santa Barbara

Effect of grazing on reproduction. Project listed by Office of Grazing.

Tahoe

1. Use of chemicals in eradication of poisonous plants on the range. Project listed by Office of Grazing.

2. Artificial reseeding depleted ranges on the east side of the Sierras. Project listed by Office of Grazing.

Inyo

Studies in methods and costs of controlling erosion along water courses. Project listed by Office of Grazing.

Sierra

Effect of opening up by logging of stands on subsequent reproduction.

REPORT OF THE OFFICE OF FOREST PRODUCTS

The outstanding occurrence of the year affecting Forest Products from an administrative standpoint was, of course, the transfer, on December 1, of the Office of Forest Products from the District administrative headquarters to the California Forest Experiment Station. This transfer will bring some realignment of objectives and program along with those which were already foreseen as a result of the anticipated cleaning up during 1927 of a considerable portion of the miscellaneous projects of the past few years. This cleaning up has been accomplished to an appreciable extent. A discussion of the realignment contemplated will, however, be taken up in connection with the plans for the coming year, following the statement, below, of the status of the projects of the past year.

Scheduled Projects, 1927

Wood Preservation Projects

Marine Piling

The long drawn out project of the San Francisco Bay Marine Piling Committee was completed during this year. This involved the completion and publication of the final report which represents a volume of over 350 pages with 45 tables and 143 half-tone and line-drawing illustrations. The reception of the report by scientists and engineers has been most gratifying. The entire balance of the issue after the distribution to members and financial supporters of the Committee has been turned over to the University of California, proceeds of sale to be applied to the furthering of similar research under Professor Kofoid. The Committee has been dissolved. The project is closed.

Wood Preservation Inspections

These still continue on the Products program as in past years. Some of them should be closed, however, within the next year or two. The only current additions are the installation of occasional marine piling materials requested by the Forest Products Laboratory and certain test specimens remaining from the marine piling project for whose continued inspection the Products organization has undertaken responsibility.

Termites

The termite situation in southern California took some time during this year, including especially suggestions in collaboration with Dr. Meinecke for the revision at the request of Dr. Snyder, of the Bureau of Entomology, of his tentative building code provisions for protection against termites and decay, and cooperation in trying to secure the inclusion of such provisions in the uniform building code compiled by the Pacific Coast Building Officials Conference. Mr. Hill was called

upon to address, as technical advisor, two meetings of lumber groups, one in San Francisco and one in Los Angeles, called with a view to financing a trip to California by Dr. Snyder. Cooperation was also given to Dr. Snyder while here. The effort by Dr. Snyder and Mr. Hunt, of the Forest Products Laboratory, to secure provisions of the kind indicated in the building code was successful. This closes this subject as a project. No demand is expected during 1928 other than calls for advice in respect to local termite attacks such as have occurred in the past.

Lumber Seasoning Projects

Air Seasoning Study

The considerable body of additional data required from this District for the issuance of the proposed Department bulletin on "The Air Seasoning of Western Softwoods", was completed and transmitted to Mr. Fullaway at Missoula. This, with later critical reading of the manuscript and correspondence discussion of points at issue, again closed this project.

Lumber Depreciation

In spite of the need for the correlation of lumber depreciation data heretofore gathered in this District, and the desire of this office to do the work for the benefit of the District timber sales administration, it was not found possible during the year to carry out the correlation of detached study results desired by them. A study was made, however, of the data available on the depreciation of fire killed timber, for the benefit of the salvage operations on the Bogus Mountain Burn of the Klamath National Forest. An interesting result of this was that the result of the actual cut for the season by the salvaging company, with defect found, checked Mr. Brundage's appraisal forecast in respect to operating costs, within 4 cents per M feet, Brundage's appraisal being $22.86 and the Company's cost $22.82.

Prevention of Blue Stain in Lumber

The Office of Products, at the suggestion of the Laboratory, joined with the Sugar Pine Lumber Company of Pinedale during the summer and fall of 1927, in preliminary experiments which that company proposed to conduct with the proprietary lumber blue stain preventative, Fungimore, and also in the dipping of a large volume of stock for overwinter drying to be carefully inspected for degrade in the spring of 1928. The work was not contemplated at all when the program for 1927 was prepared, but the solution of the blue stain problem is so important to the California pine region operators that it was deemed best to accept the invitation. Dr. Meinecke is also expected to take part in this project.

Preliminary work on a small scale indicated promising results, but the effectiveness of the chemicals in preventing or retarding blue stain development during the severe winter season - the real test - will not be known until the several piles of dipped stock, together with a similar volume of undipped controls, are inspected and graded during the coming spring. Brundage has prepared all the reports covering the progress of the work to date. In fact, had he not been able to steer the work it would have failed to have any satisfactory organization or control so as to give its results conclusive value. He will have to be ready to go to Pinedale for the final inspection as soon as the company notifies us that the lumber is dry enough for shipping. Field work will require at least two weeks, and preparations of the final report will take the better part of a month.

Some girdling experiments with sugar pine trees are being conducted by the same company, both to observe the effect on subsequent blue stain development and any possible saving of time in seasoning due to reduction of moisture content prior to felling. The company has promised to inform us when the trees are brought in from time to time and some member of the Products office should give two or three days to following up this work.

Studies of Utilization Efficiency and Waste

Logging and Sawmill Waste

Only preparatory work was contemplated on this project during 1927. In accordance with the plan Mr. Brundage was absent from the District for approximately four weeks in July and August, spending two weeks in a going sawmill study in District 1 and another week in visiting woods and mill operations in District 6 with special reference to their woods waste studies. Observations were made with a view to this kind of work, in some sawmills in California, but Mr. Hill was prevented by physical disability from making as thorough a survey of mill practice in the state as it had been hoped could be made. The stage is reasonably set, however, for definite project work in the future.

Little Used Species

The largest item in this study has been white fir on which all districts and the Forest Products Laboratory have been working as a joint project for several years. Field observations and interviews concerning the manufacture, seasoning, uses and marketing of white fir in California have included enough mills, retailers and users in all parts of the state to give a pretty clear picture of the situation. The final report on this phase, for this District, is now nearly completed.

White fir has already won its way into eastern markets, especially in building construction, in thecase of the larger operators with sufficiently extensive sales organizations - and has lost it again

in several instances due to short sighted unwillingness on the part of the manufacturers to cater to the needs of the retail trade. The ruinous competition of Douglas fir, marketed below the cost of production, has in many regions been a serious factor, nowhere more so than in parts of California itself.

Here, however, and to a less extent eastward because of the longer interval involved between production and use, the chief difficulty is the failure to supply properly dried stock. From our standpoint white fir is fortunate in that the preferences of both the ultimate user who wants his lumber to stay in place and of the contractor and carpenter who usually look no farther than their own convenience in nailing and working, agree in calling for dry lumber, instead of, as frequently in the case of other woods, like redwood and eastern hemlock, being in conflict.

Adding to the difficulties of the problem, not only in selling the product but in increasing the manufacturing costs and aggravating the manufacturer's losses, are many current manufacturing practices which die very hard. An example is the excessive adherence of the California pine industry to the standard 16-ft. log length. This leads to his serving his retailer badly when the latter wants specific lengths rather than random, as initial stocks run low, and leads to excessive waste of white fir in the woods due to failure to adapt bucking length to doty spots in the bole. Operators often say they are losing money on the fir they bring in now, and don't want to increase their load, failing to see that their neglect to realize all that they might from the logs for whose felling they have already paid, only adds to their losses.

In view of the silvicultural problem presented to the forester by white fir in the woods, the problem of white fir as a little used species involves silviculture, forest pathology, fire protection, logging practice, sawing practice, green chain grading, seasoning practice, remanufacture and preservative treatments, at the minimum. In other words, future work on this species should go away from markets and uses, and first to what actually happens in the conversion of this species in the woods and the mill.

In respect to incense cedar and California Douglas fir, as indicated in last year's plan, only such information was gathered as could be picked up incidental to other work. In connection with these species, as with white fir, while new uses, etc., upon which information is received, should doubtless continue to be followed up as far as time permits, it is felt that the most profitable attack from now on is in the study of actual producing conditions in the woods and mill. This will come in connection with the general studies of logging and mill waste which are contemplated.

Forest By-Products

Heptane

This investigative project, which was foreseen at the time of last year's report as possibly necessary but which had not then definitely developed, was made necessary by the issuance of a cupping permit on the Lassen National Forest for the collection of heptane from Jeffrey pine by the California Chemical Corporation. A very late spring retarded the beginning of the work both on the cuppage sale and on the experimental research. Experimental work was, however, carried out on and adjacent to the commercial sale area over a period of between two and three months ending with September 30. Records were kept of climatic data in considerably more detail than has been done on any previous Forest Service experiments of this kind, and in addition data upon soil moisture content. Records were kept of the yield of oleoresin from some 369 cups on 260 trees. This furnished data directed toward the influence upon yield of some seven different variables in tapping practice, including width and exposure of faces, height of streak, double vs. single chipping, angle of chipping, covered faces and covered cups, upward peak faces, and width of bark bars. The data secured seem to indicate the possibility of very interesting and valuable conclusions, could the work be continued in subsequent years. It is obvious, however, that not a few of the variables will show much, if not practically all, of their significance only after more than one season of chipping. Because of technical disputes encountered by the Ethyl Gasoline Corporation from oil company chemists regarding the validity of the heptane-octane measurement of gasoline knock, the renewal of the cuppage contract was embarassingly delayed and it was feared that the commercial operation would be discontinued. This will now be renewed, however, and the experimental work should go on. Among results of present value, regardless of future work, may be noted the demonstration that heptane and terpenes are never mixed in the product from the wood of the same tree; that the identify of a tree as a heptane yielding tree can be satisfactorily established in the field by means of the odor; and that, notwithstanding the production of heptane only from the wood of Jeffrey pine trees, the bark of such trees behaves like that of other pines, yielding terpenes and not heptane.

Economic Investigations

Lumber Census

This cooperation with the Bureau of the Census has continued as usual and apparently will be continued.

Lumber Prices

This also continues as in former years, to the extent of reducing to graphic representation the statistics issued monthly by the Pine Association. Data for redwood products continue to be lacking. No retail prices were collected in 1927.

Stumpage Prices

The usual questionnaire was sent out with the lumber census and supplemented for report to Washington by data assembled for this office by Forest Management.

Lumber Distribution

The annual tabulation by the California Pine Association was copied as in the previous year.

Major Uses of Wood

No progress was made with this project in 1927 due to insufficient personnel.

California Economic Research Council

This work seems to justify Forest Service participation in it, not only in respect to the value of forwarding an interest in research in this state and the better coordination of such research, but in the forwarding of cooperation in research which will be of direct value to the Experiment Station and to the Forest Service. Subjects in which the Council Committee on National Resources, of which Mr. Hill is chairman, has been able to initiate activity or promote helpful cooperation, are the issuance of a climatic handbook for California and the extension and coordination of snow surveys. The Committee is now also working upon the extension of investigations being carried on at the Scripps Institution of Oceanography on the effect of Pacific Ocean surface temperatures on the climate of California and on the extention of United States cooperation in the international measurement of ocean temperatures, these being at the instance of Dr. T. Wayland Vaughan, Director of the Scripps Institution and Chairman of the International Committee on Oceanography of the Pan-Pacific Scientific Congress; a survey of the remaining sea otter and fur seal of the California coast; and the preliminary clearing of the ground for a comprehensive cooperation of state and other agencies with the Experiment Station, looking toward a thoroughgoing land use survey and classification for this state.

Cooperation with the Forest Products Laboratory

Cooperation of this kind at the request of the Laboratory is on constantly varying subjects. Although these subjects are not planned as projects in our program they are usually of project character and such cooperation comes in each year for an appreciable slice of Products time. In order therefore to bring them into the picture for which time provision must be made, it is deemed better to group such items under a cooperative heading than to discuss them under the subjects which happen to be covered in a given year, as has been done

in the past. The subjects thus calling for attention in 1927 were, first, the Laboratory's moisture content project, in respect to which the Products office assembled data and made a report on the probable moisture content of lumber shipped from California mills under summer conditions, to supplement the data previously gathered in detail in this region in respect to winter conditions; the redwood specific gravity survey, in which cooperative assistance was given to Messrs. Leopold and Luxford during their trips to and work in this region; and completion of the weighing of moisture equilibrium samples, which has been in progress for some two years. All the items were completed as desired. Since, however, the need for cooperative assistance in Laboratory projects has in the past come up with each year, and such cooperation as is possible without injustice to our own necessities should not, by common agreement, be withdrawn, this semi-project designation, as a measure of time demand to be considered in our program, must be considered as a continuing one. (See Investigative Committee recommendation at end of Products section.)

Plan for 1928

The plan for this year should be made in the light of the somewhat changed conception of Forest Products objectives as now arrived at. Formerly Forest Products work, especially at the Forest Products Laboratory, but to a lesser degree also in the field units, was concerned mainly with problems of the wood industries on their own terms, without adequate reference to the effect upon forestry in general or upon service to other problems of the Forest Service. Within recent years there has been increasing emphasis upon the obligation of Products for service to the administration of the national forests, as the main job of the Forest Service as a whole. More recently there has come a shift of emphasis to the conception that, in a national point of view, the main objective of all foresters, but especially of forest research workers, must be the increased application of forestry practice in the woods of the nation as a whole, regardless of ownership.

Practically every line of traditional Forest Products activity would be legitimatized by this viewpoint, when resources in men and money are sufficient to meet demands. On the other hand, the acceptance of this objective has very great, and perhaps chief, value in determining priorities when resources are inadequate to the work pressing for accomplishment. Insofar as the statement of the major objective of forest research, as the accomplishment of its maximum contribution towards forestry in the woods themselves, regardless of ownership, takes into account the fact that four-fifths of those forests are in private ownership, the emphasis also will shift back again toward the problems of the private owner. It will require consideration of the problems of industry to the extent that it is true that a healthy forestry can only be practiced by a healthy lumber industry; but it will require that any industrial problem, to be accepted by the Station, shall contribute toward the major end of the actual practice of forestry and not solely to immediate industrial advantage. Under such a major objective, for example, Forest Products

could hardly today devote research time to the problem of the making of smoking pipes from California chaparral woods, upon which considerable Products resources were spent in this District some years ago. Private or industrial problems which cannot meet the test imposed by the above objective will have to be undertaken by the industry or, as at the Laboratory, at their expense. Such an objective will constitute our best protection, not only against program pressure, but against the imputation of government tax paid Forest Products research as an unwarranted subsidy to the lumber industry.

Looking at the foregoing statement of the year's work in Products, it will be seen that, of the projects reported upon, five have been completed and closed. Of the remainder, those dealing with lumber prices and lumber distribution, and to a somewhat less degree stumpage prices, are of a considerably routine character, taking a comparatively small amount of time and hardly worth being given the rank of individual projects. On the other hand, they are definitely aimed at the accumulation of statistical information essential for economic studies. It is therefore proposed to group them under a project title, "Minor Statistical Data". With this grouping, and including as a project such work as may be done at the request of the Forest Products Laboratory, there are eleven listed projects remaining for consideration in respect to 1928. Of these, however, six (wood preservation inspections, blue stain, lumber census, minor statistical data, Economic Research Council cooperation, and Forest Products Laboratory cooperation) are either of such a nature as to be impossible of discontinuance or have been definitely approved in the past, and, therefore, can not be eliminated from consideration in respect to continuance in the program - unless it is desired to reconsider the whole situation.

This leaves for approval or disapproval, the following five projects:

Lumber depreciation
White fir study
Logging and sawmill waste
Heptane
Major uses of wood

Lumber Depreciation

This project has been explained in previous annual reports. It has been most unfortunate that its completion has not been possible. Besides the need for it in the Office of Forest Management, this project will tie in so directly with the major results to be secured in the Pickering project that it should by all means be done this year. With the cleaning up of the program which has now been accomplished, it is believed that this project can now be carried through. (See Investigative Committee recommendation end of Products section.)

White fir

What should first be secured in preparation for woods and mill waste studies is a reliable picture, now wanting, of the results, in cost and wastes, in present practice. Then can be tackled the problem of how to get best results. For the former, one of the best possible ways of approach is a combined silvicultural and products study such as is now contemplated by the Station and which will be discussed under the plan for 1928. In the meantime and pending suggestions from Madison as a result of our report, it is proposed that Brundage be allotted a month's time for the preparation of articles for publication in trade journals on the west coast, directed primarily at the white fir producers, special emphasis to be laid on the complaints of users and what the mill men can do to overcome them. Reprints should be sent to every pine region mill having an annual cut of one million feet or more white fir with a letter asking for comments and criticism. Replies to these will indicate what the producers are willing to do themselves for the rejuvenation of the California white fir market and should correct any of our conclusions which may rest on false premises. Without a doubt, some operators will reply that white fir cannot be seasoned properly without excessive degrade and loss. Others will reply that the lumber must be surfaced at 20 per cent moisture content or thereabouts to prevent large losses in remanufacture. This will give us a knowledge of the sentiment and an opening to broach the subject of future cooperative studies to a few operators who are interested enough to make such studies really worth while.

Pickering Project (includes logging and sawmill waste).

First priority among the above Products projects should go unquestionably to that on logging and sawmill waste on its intrinsic merits and the amalgamation of Forest Products with the Experiment Station in this region here gives the first conspicuous opportunity to increase the effectiveness of both silvicultural and products research through increased correlation between the projects of these two lines of work. The Station has had in prospect a study of logging methods in respect to damage to reproduction and other factors on an area in the operations of the Pickering Lumber Company on the Stanislaus National Forest. It is now proposed that Products shall study the same operation with respect to the logging wastes and the character and value of material taken from the area, and shall carry this study clear through the sawmill, the seasoning, etc., of the product, and to the loading deck. Through such a study it will be possible to obtain for that area information of a completeness not obtained in any previous study, this information extending from the composition and character of the original stand through the amount removed, and the amount remaining, damage to reproduction, the waste left in the woods, logging costs by species, and transportation, to the mill and the wastes and losses there involved. This study can also be made to furnish precisely the background information desired for white fir

as a basis for further special studies in respect to that little used species. This Pickering project will be of such magnitude as to constitute the ranking project for all lines of the Experiment Station organization, and will require the mobilization of all the assistance from other sources which can be mustered. It is hoped that the Office of Forest Management will cooperate, as well as the Forest Products Laboratory, if possible.

Heptane

In view of the renewal of the cuppage sale, the discontinuance of the experimental work would be very unfortunate. A way to finance it without increased special schedule funds seems now to offer in the desire of the Bureau of Entomology to pursue chemical studies of the cause of attraction of particular species of pine for the species of Dendroctonus which attack them. Mr. Tihomiroff, who conducted the 1927 heptane field work is particularly qualified for this new phase, and it appears feasible to carry on both lines of work simultaneously. An arrangement has therefore been approved for cooperative financing of the work. Field work will commence again about the middle of May.

Major Uses of Wood.

This project is of real importance in connection with the general economic study of the Station. In view, however, of the lapse of work upon it since the death of Mr. Hodge and the scale upon which it should be attacked to be really effective, it is not felt wise to attempt a renewal of work upon it this year, or until increased Station personnel and resources are available. (See Investigative Committee recommendations end of Products section.)

Wood Structure of Chaparral Species

A new proposal is that Products undertake a study of the identification of the wood structure of chapparal species. There is immediate need for such information in ecological studies, especially in southern California, both in connection with fire problems, type mapping, and grazing ecology. By its aid it would be possible from the stumps or other woody remains following severe fires, to determine the species composition of the cover existing before the fire. (See Investigative Committee recommendation, end of Products section.)

Besides the value of such a study, there would be considerable advantages in being able to conduct it locally, although it would also be possible to send material for the study to the Forest Products Laboratory. It is felt not to be wise to attempt the study here until more man power is available for Products work.

Economics of Wood Pulp and Paper Production in California with Reference to National Forest Sales.

Mr. Woodbury has broached the desirability of Products cooperating with Forest Management in a study whose object and nature he thus describes in his memorandum for the Investigative Committee:

> "To determine under what conditions, if any, wood pulp production will yield a reasonable profit in this State. It seems to me that this study could be undertaken by determining in advance as accurately as possible the requirements necessary for a successful pulp operation, then attempting to select a location that apparently meets these requirements, and, finally, making a close study of this particular situation to determine in detail, availability and cost of necessary water, power, raw materials (including woods waste and round material) and other essentials. Forest Products already has a large amount of general information on this subject. It seems to me that what we need most is the application of this information to an individual situation so that we may have a concrete guide, or measuring stick, which we can use in passing on tentative pulp production plans that are occasionally placed before us involving national forest stumpage. Forest Management would be glad to take part in any phases of this subject which we are best qualified to handle, such as cost of delivery of pulpwood at any agreed upon point."

Forest Products recognizes as keenly as any one else how far short such knowledge as it has of the general economics of the pulp and paper field is from the technical pulp and paper mill engineering equipment necessary for dependable conclusions in such a concrete appraisal. I agree with Mr. Woodbury, however, that such a study would give us a much clearer understanding of the problem than is now available and should be of very considerable service to both offices. Combining both agreement with our research objective and service by research to the National Forest administration, such a project should have high priority. In the light of Products program commitments already discussed, however, I cannot see how it can be taken on by Products this year - unless, for example, the Pickering project should for some cause fail to be carried through this year. (See Investigative Committee recommendation, end of Products section.)

Discussion by Committee

The program submitted was in general approved by the Committee. It suggested, however, -

1. That extension work should as far as possible be turned over to the local office of the National Lumber Manufacturers Association.

2. That the lumber depreciation study be given high priority and carried out this year if at all possible.

3. That the proposed project on the identification of chaparral woods be dropped as recommended by Hill.

4. That the study of major uses of wood be further postponed till Station resources are more adequate to attack it in a big way.

5. That the pulp and paper economics study be taken up if any other project should drop out which would give it space.

6. That the fitting into the local Products program of cooperation desired by the Forest Products Laboratory without disruption or dislocation of work, would be greatly furthered if the Laboratory could give notice of such needs early enough in the year to incorporate them in the field season schedule, or at the annual Products Program Conference at Madison.

REPORT OF OFFICE OF FOREST MANAGEMENT

The following is a summary of the results of the investigative or semi-investigative work done during the past season, largely under the direction of the Office of Forest Management, with suggestions for future work.

Tractor Logging Study - Strawberry Unit Sale

Stanislaus Forest

This project was proposed and approved at the last meeting of this committee.

The California Forest Experiment Station cooperated with the Forest Management Logging Engineering Division in making the study of damage. The Logging Engineering Department of the University of California School of Forestry furnished assistance in making a time study on the same area. A separate report on this phase of the project will be prepared under Logging Engineer Berry's direction this winter.

A 15.5 acre sample plot was laid out in June, 1927, in Section 20, T. 4 N., R. 18 E., M.D.M. on the Pickering Lumber Company sale (Strawberry Unit), Stanislaus National Forest. Both gentle and steep slopes were represented as well as the usual mixture of coniferous species. Although 88 per cent of the trees in the reserve stand were under 30 inches D.B.H., 57 per cent of the volume was in larger trees. Poles, saplings, and reproduction filled the openings between groups of larger trees.

Each tree 3.6 inches D.B.H. and larger was located by plane table and stadia method and shown on a map. All such trees were recorded by number, species, diameter, height and tree class. Fully stocked areas of reproduction were also mapped.

Results

The area was logged during July with five Caterpillar-60 tractors. The examination after logging disclosed that practically all of the damage to trees over 12 inches D.B.H. was caused by the felling of three unmarked trees of fair size. Only one small tree was destroyed by the tractors. Five small trees under 20 inches in diameter were destroyed by the felling process, amounting to only 2.5 per cent of the number of trees and .4 per cent of the volume in the reserve stand.

In the 3.6 inches to 11.9 inches D.B.H. class, skidding as well as felling is responsible for a material amount of damage, although felling is still responsible directly for 60 per cent of the damage done and indirectly for a somewhat higher percentage. In this diameter

class, about 200 trees out of 1040 trees were injured, or destroyed by felling and skidding. The effective survival increased directly with diameter.

foot

In the 0-5/class the direct destruction is done by skidding and the indirect by falling and poor planning of the logging. That is to say, the young trees are crushed and destroyed by the logging machines but the necessity for the machine to enter a particular bunch of young growth is determined by the falling, and the planning of the tractor roads. The effective survival in this class was 76.9 per cent for stuff 5 feet high to 4 inches D.B.H., and 67.9 per cent for stuff 0 feet to 5 feet high, or an average of about 72.6 per cent.

Conclusions

The results of this study do not vary materially from those secured in three other similar studies and tend to confirm our administrative regulations for handling tractor logging, which were worked up and put into effect last season. The study emphasizes our main finding of the past, that on sales of any size, the operator must be required to furnish a full time, skilled employee to supervise caterpillar logging. (See last year's report for details of regulation.) No further studies along this line are called for, pending new developments in this type of logging.

Stanislaus and Lassen Slash Disposal Experiments

Stanislaus

The logging on this area was completed in 1925. We are still maintaining our detection and protection system, and shall be able to do so for some years to come, using funds deposited with us for that purpose by the Pickering Lumber Company. It is hoped that special protection may be given the area, until the logging debris hazard has disappeared.

The following are the high lights of this year's annual report on this project:

A lookout and two patrolmen were employed, June 1 to October 27. There are three tool caches on the area. Hell's Half Acre trail was cleaned out from the Highway to sale boundary, at a cost of $48, and three miles of fireline, 50 feet wide, was constructed along the lower boundary of the sale area, at a cost of $706.63 per mile. The total expenditure for the year amounted to $4,728.70.

Only one fire, covering .017 acres, occurred on the area this year. This fire was caused by blasting by the State Highway Commission. It was discovered within 15 minutes from the time it started.

The logging railway through the area was removed this fall and next spring the railroad grade will be leveled for use as a motorway. This will facilitate fire prevention and suppression.

Lassen

This experiment was reported on fully last spring. The plan outlined at that time is being carried out in good faith by the Fruit Growers' Supply Company and no fires of any consequence have occurred on the experimental area. The experiment was inspected and approved by the Forester and Inspector Fitzwater during the past year. After my last inspection, I suggested, (a) that more care should be exercised in keeping brush piles on the fire lanes away from green trees left, (b) that young stands on the fire lines should be thinned more where there is danger of fire crowning, and (c) that the merchantable timber on the fire lines should be marked heavier to avoid crowning in case of fire.

The following is a brief summary of this year's report:

Bridge Creek Unit (private land)

25.4 miles of 100 foot wide fireline was constructed at a cost of $329 per mile. 4.74 miles of right-of-way was cleared. 12 miles of railroad grade was converted to motorway. 12,644 snags were felled on 3,900 acres (62 cents per snag). Four fires covering a total of 1 acre occurred and were suppressed for $110.45. Total expenditures for the year were $18,513.23.

Logan Mountain Area (largely national forest land)

17 miles of fireline, largely 100 foot wide, was constructed at a cost of $338 per mile. 12 miles of railroad grade was converted to motorway at a cost of $43 per mile. 5,309 snags were felled at a cost of 61 cents per snag. 7 fires were handled, totalling 2 acres in area, at a total cost of $74.50. 915 acres of tops were lopped (representing 9,210,820 feet B.M.) at a total cost of $228.69 (2.5 cents per M.B.M.) Considerable maintenance work was done on fire lines and roads constructed in the past. Mileage not given. Total expenditures for the year were $11,578.67.

Total expenditure for the year, both units, was $30,091.90, or approximately $1.20 per acre.

Supervisor Durbin points out that some of the work reported in connection with this project, such as clearing of railroad rights of-way, patrol and detection, construction of Eagle Lake Road, and fireproofing of Pine Creek Road, is required under the terms of our timber sale agreement with the Company, or would have been done for their own convenience and is, therefore, not properly chargeable against the experiment as a cost item.

No adequate test has as yet been secured of this fire line and patrol system of fire protection on this area.

Forest Management Record

This record was described in last year's report and it was suggested that a cooperative study, with the object of improving and simplifying the office and field technique, be undertaken by Management and Research. This suggestion was approved.

Wieslander, of the California Forest Experiment Station, and Dunston, of the Office of Forest Management, were assigned to this study. The Plumas, Sierra, Tahoe, and Stanislaus forests were visited by them during September. The ideas of the field men on these forests regarding improvement of the Record were secured, and proposed changes in field and office methods were illustrated.

Wieslander and Dunston have prepared a comprehensive report, recommending changes in the system. This report was forwarded to the field on September 27, 1927, for comment and criticism. Replies are being received and we intend to get out instructions embodying the new procedure before the field season opens.

The following summarizes briefly the suggested system:

Tally trees in two classes. i.e., "dominant" and "others", classing codominant trees as dominants. Since growth calculations are based upon dominant and co-dominant trees it is necessary to have these classes segregated.

Reproduction conditions are to be secured from eight one-half square chain plots in each 40 acre tract. This system gives a one per cent estimate of reproduction. Reproduction is recorded graphically on a Form 878 containing 100 spaces for each plat. The scale is such that each square represents a 6.6 foot square on the ground. By recording on the sheet the number of squares occupied by reproduction, the per cent of the plot stocked with reproduction may be secured directly by counting the occupied squares.

Office Record

It is planned to discontinue the Atlas size sheet record and to provide more flexibility in the scheme by filing the records in a vertical file. The record will be made up of the following parts:

1. A cloth-mounted index map of the forest for showing graphically the progress of the cut-over area cruising work.

2. A 4-inch scale map of each section showing types, sites, culture, area logged by years, and method of logging.

3. A sheet containing, in summarized form, information regarding year of cutting, marking practice, logging methods, method of slash disposal, ground cover, etc.

4. Summary of original cruise of section on letter size sheet TS-5 and summary of cut-over cruise on similar sheet.

5. Stand tables on separate sheets.

6. Brief description of reproduction conditions based on two classes 0-6 feet and 6 feet to 3.5 inches.

7. If serious losses occur, they will be described as to character of loss and volume of timber destroyed.

Taxation Study

The study of the effect of national forests on county revenue, initiated in this District, was mentioned in last year's memorandum. Last fall, the Forester's office initiated a more detailed but similar Service-wide study, which called for a large volume of additional work on our part. Logging Engineer Ayres handled this work, with some assistance from the forests. Briefly, this study shows, for California, that the sum of income, assistance and benefits from the national forests for the year 1927 equals, within $15,000, the sum of the taxes which would be yielded if all desirable national forest land were patented. The two main credit items are, of course, $291,437.75 - 25 per cent fund, and $1,149,368.36, road and trail expenditures. These two sums make up 90 per cent of the total sum of income, benefits, and assistance from the national forests. The study shows, in a striking way, that the national forests of California are now paying their full share of the expenses of county government and that in the near future many of the national forests will pay considerably more than this fair share. The study shows a recent wild orgy of spending in many counties and brings out clearly that, until these counties commence to practice economy, they cannot, with clean hands, instigate agitation for a greater share of national forest receipts. It is further shown that, under the present scheme of distribution of the 25 per cent fund, the receipts by counties with approximately equal national forest areas vary widely, due to fluctuations in volume of productive national forest business. As pointed out by the District Forester, this could readily be corrected by distributing the entire state fund to counties on a national forest area basis, without regard to specific national forests.

Experimental Planting

The following experimental planting of western yellow pine has been reported for the past calendar year:

Sierra	2.88	acres
Stanislaus	8.74	"
Tahoe	4.5	"
Total	16.12	"

The planting stock was derived from the Feather River Experiment Station nursery.

Miscellaneous

Reports on several minor research projects conducted by, or proposed by, Forest Supervisors have been received here and transmitted to the California Forest Experiment Station. It is presumed that these projects will be touched upon in the report of the Director and therefore they are not covered here.

Some experimental fire line construction work was done on the Strawberry Unit sale, Stanislaus, in cooperation with the Pickering Lumber Company, to protect both the sale area and nearby summer homes. Also, marking boards were assembled on the above sale and in cooperation with District Six on the Fremont Forest in Oregon. It is doubtful if these projects should be classed as research, although they were mentioned in last year's report, and further information regarding them will not be furnished unless requested.

All of the work proposed for the year 1927 has been done except the check donkey logging damage study, Strawberry Unit sale, Stanislaus, and the study of depreciation of tractor logging equipment. The former project could not be undertaken because no suitable area for study was being logged by donkeys at the right time. The latter can hardly properly be called research. Some information has been collected on depreciation and further data will be secured this spring when we secure our reports from operators on the cost of 1927 operations.

Proposed Investigative Work for the Year 1928

The following projects bearing on Forest Management work are suggested for the consideration of the Committee. At the present time we do not contemplate carrying on any Logging Engineering, or other investigative work, this year with the office personnel. We could arrange to cooperate, however, to some extent in connection with certain phases of these projects.

Project - Study of Timber Types

Purpose

The standard classification of Forest Types described on pages 28-45 of "Instructions for Making Timber Surveys in the National Forests", 1925, does not appear to be of practical use in certain phases of both Research and Forest Management work. In timber sale and timber appraisal work, type maps are ordinarily consulted to determine the percentage of the more valuable species in the stand, as a basis for deciding whether or not certain timbered areas are merchantable. Several of the present types do not give this information. For example, in the western yellow pine - white fir combination, areas may be typed as fir type (unmerchantable), which in reality have been found to contain as much as 18 M per acre of western yellow pine (merchantable). It is felt that it would be worth while to make a study of timber survey data and combinations of species, with a view to suggesting changes in the present type definitions which would make these definitions more expressive of the present merchantability of the areas in question. As has been suggested, stand maps would furnish this information but if it can be secured by a change in type definitions, the considerable labor involved in the preparation of stand maps would be avoided. There seems to be some prospect that the desired result can be accomplished by lowering the percentage of number of trees of the more valuable timber species which constitute a type. The solution of the problem is not clear, which suggests at least discussion by the committee and, perhaps, further study.

Project - Determination of Conditions Justifying Blister Rust Protective Measures

Purpose

This question has been brought up by the Office of Blister Rust Control at previous meetings. From a purely business standpoint, the area in the sugar pine type to receive protection should be capable of producing periodic sugar pine increment of sufficient value to cover the cost of periodic protective work. In addition, sentiment and the silvicultural advantage of mixed stands would dictate a fight against blister rust at least on certain areas within the optimum sugar pine belt, unless the cost of protection is very excessive. The blister rust threat appears to be looming larger every year, which indicates that we may have to undertake control within 5 or 10 years, or allow the rust to run its course. In this connection, it would appear to be desirable for the California Forest Experiment Station to push actively a study of sugar pine reproduction and collection of sugar pine growth and yield data. With information on cost of control, reproduction and growth and yield available, it would be possible to outline, roughly, using timber survey data largely, the area to be protected.

Project - Study of Practicability of Wood Pulp Production in Calif.

Purpose

To determine under what conditions, if any, wood pulp production will yield a reasonable profit in this state. It seems to me that this study could be undertaken by determining in advance as accurately as possible the requirements necessary for a successful pulp operation, then attempting to select a location that apparently meets these requirements, and, finally, making a close study of this particular stiuation to determine indetail, availability and cost of necessary water, power, raw materials (including woods waste and round materials) and other essentials. Forest Products already has a large amount of general information on this subject. It seems to me that what we need most is the application of this information to an individual situation so that we may have a concrete guide, or measuring stick, which we can use in passing on tentative pulp production plans that are occasionally placed before us involving national forest stumpage. Forest Management would be glad to take part in any phases of this subject which we are best qualified to handle, such as cost of delivery of pulpwood at any agreed upon point.

Discussion by Committee

The Committee recommended early publication of the results of all the tractor studies so far conducted in this District. It approved the program of new work proposed.

REPORT BY OFFICE OF RANGE MANAGEMENT

The status of the needs for grazing investigations have been fully outlined in the memorandum of previous years. These needs do not become less but the demand seems to grow as the application of better range management proceeds. As brought out before we feel a great need for attacking range research on a larger scale with a broad program and anxiously await the time when the work of the California Forest Experiment Station can be enlarged to embrace at least the more pressing problems affecting grazing administration.

In the main the work outlined during the past year has been carried forward according to schedule. Some of the projects are lagging and on others more work has been done than planned. On the Tahoe Forest it has been possible through the cooperation of grazing permittees to undertake a study of erosion control and of artificial reseeding. Project sheets have been prepared for these which cover them in detail.

The outstanding work of the past year has been in connection with the chemical eradication of poisonous plants. The results so far indicate the feasibility of this method of control in many instances.

The study of the forage requirements of deer is yielding some excellent material and when carried to its conclusion will be of great value in game management.

The possibility of establishing vegetation quadrats in connection with the silvicultural studies on the Lassen Forest are being considered. It is understood a number of reproduction sample plots have been layed out in an area to be cut over this year. A knowledge of the effect of the removal of timber on the forage stand will no doubt be of value in future grazing administration. The grazing reconnaissance party will be able to undertake this project.

At the request of the Bureau of Plant Industry, Mr. Cronemiller will make an examination of an infestation of a new weedy grass, Aegilops triuncialis, in Calaveras County which is causing mechanical injury to livestock in that section because of its sharp and barbed seed heads. The details of this examination are covered in a project sheet.

Discussion by Committee

Projects proposed were approved by Committee.

REPORT OF OFFICE OF FOREST ENTOMOLOGY

The research work in forest entomology for District 5, during the 1927 season, included studies on the Sierra, Modoc, Inyo, and Shasta national forests. Studies by Keen and Patterson, of this office have been continued also in the Klamath Falls region of District 6. The studies have been grouped under the same project headings that were used in the 1927 report.

Barkbeetle Control

Control work in District 5 was limited to two small cooperative projects in the southern part of thestate. 109 trees were treated on the Lake Arrowhead area of the San Bernardino National Forest and 30 trees were treated on the Figueroa Mountain area of the Santa Barbara National Forest. Nothing of value to research was gained from these operations because it was not possible to detail a man to them for investigative study.

The seventh annual survey of the southern Oregon - northern California control project was carried out by Keen with the help of three assistants. In connection with the survey extensive studies were made on tree selection and the relation of site, elevation, exposure, and other factors to western pine beetle infestations.

Because of the critical situation on the Modoc area a special survey was made to furnish the Forest Service and private owners a basis on which to determine whether or not some action should be taken. A report on this survey was recently made by F. P. Keen.

Patterson continued the clean up work on the lodgepole pine infestation in Crater National Park. He has also been following the results of barkbeetle control work done by private protective associations in the vicinity of Klamath Falls. This work continues to show fairly good results.

The study of the biological factors affecting the control of the western pine beetle was continued for the third season at Northfork, California. The purpose of this study is to determine the importance of natural enemies and how to utilize them in artificial control work rather than to destroy them. It was soon found that the predaceous clerid, Thanasimus nigriventris, is the most important insect enemy of the western pine beetle and so its habits and importance as a control factor have been studied in considerable detail.

The 1927 studies of T. nigriventris, confirm the results of the 1926 work. The concentration of this clerid on the first generation summer trees is so pronounced that artificial control on these trees would usually do more harm than good. As many as 50 of these beneficial clerids have been found in one square foot of bark, which is greater than the emergence of the western pine beetle in many cases.

Preliminary work has also indicated the value of a cerambycid, Graphisurus spectabilis, in reducing the western pine beetle broods by robbing them of their food. Work on this beneficial "robber" should be continued.

More data on the flight habits of the western pine beetle are badly needed as an aid to planning control operations. The results of a limited flight study in the Chiquito basin were given out last spring. They indicated a mean maximum flight of about a mile and a mean average flight of less than half that distance. In 1927 a flight experiment was tried on Oat Mountain. An attraction was started by forcing attacks into the caged base of a tree which was a mile and a half from the nearest infestation. Attacks made above the cage indicate a flight of at least a mile and a half but the possibility of leakage from the cage lessens the value of this experiment. Any opportunity to obtain more data on this subject should be taken advantage of.

Reduction of Insect Loss Through Marking

This project has been worked on for several years and considerable progress has been made in the determination of the characteristics of the most susceptible trees and in the relative resistance to attack of different trees. The use of cages to start attacks on western yellow pine of different tree classes and vigor has been continued in the study of their relative susceptibility and resistance at Northfork.

In the study of the trees naturally selected for attack by the western pine beetle we are concentrating on the use of permanent sample plots. An 80 acre plot located at Cascadel on the Sierra National Forest in 1926 represents Site III of the west side western yellow pine type. The insect loss on this area is comparatively low. In 1927 two plots of 40 acres each were laid out on the Modoc National Forest to represent Sites III and IV of the east side type. On these two plots the insect loss is extremely heavy. Dunning assisted in the selection of the Modoc plots and the Experiment Station paid the field expenses incurred in laying them out and in taking the basic data.

We now have individual records for more than 4,000 trees with notes for each on tree class (according to Dunning), diameter, height; crown, bark and growth characteristics and exposure, slope, soil, site and type conditions. As approximately 700 or 17.5 per cent of these trees have been killed by the western pine beetle we have an excellent basis for the comparison of the characters of the trees selected by the insects with those of the trees not attacked. We already know that under the conditions studied there is a definite preference for trees of certain diameters, of certain tree classes and for slow growing trees in general. An analysis of the data now at hand will give us a basis for an experimental marking which will test the applicability of our conclusions.

It is planned to cooperate more closely with the Experiment Station on the use of their "methods of cutting" and other sample plots. Person has made use of these plots in studies of insect losses on cut-over areas and Dunning has recently worked up the insect loss on these sample plots to show the susceptibility to loss of the different western yellow pine tree classes which he has introduced. In the future, periodic insect surveys should be made to determine more accurately the amount of loss caused by each of the tree killing species of insects on each of the sample plots.

We have had in mind for the last two years the selection of a sale area, with the cooperation of Management and the Experiment Station, on which to test our tree selection theories. We believe this to be decidedly worth while and if possible it should be carried out next season.

Arrangements were made with Mr. Fowler at Timber Mountain, for cutting over 20 acres of the Timber Mountain sample plot so as to take out all of the most susceptible trees. The trees to be taken out were selected and marked and the work was authorized by giving Fowler a special use permit to work on. We were informed later, by Supervisor Lyons, that there is little hope that Fowler will take out enough trees to give us anything of experimental value.

Interrelation of Insects and Slash

The abnormal insect conditions following the heavy windfall of February, 1923, within the Mono Lake - Owens River working circle have been studied for the last four years by Miller in cooperation with the Forest Service. It was found that, following the windfall of twelve and a half million board feet of Jeffrey pine, barkbeetles bred up until they were able to attack and kill a large amount of standing timber.

The outbreak of Ips oregoni developed first and killed or top-killed thousands of small trees in the fall of 1924, and then subsided. The Jeffrey pine beetle infestation built up to a peak in 1926 and appears to have returned to a normal status in 1927. The total loss from insects following the windfall was estimated to be over thirteen million board feet, most of which was due to the Jeffrey pine beetle. A final survey should be made in 1928 to determine the extent of the decline, which was evident in the 1927 survey.

A study of the effectiveness, for insect control, of different disposal methods for right-of-way slash was made during 1927 and reported on recently by Person. It was found that in the lower, open yellow pine type the slash could be easily handled so as to reduce rather than increase the western pine beetle population of an area. When the slash could be burned within a month the surest method was to cover the trunks with brush or slashings and burn. Where burning could

not be completed before the broods had a chance to develop and emerge the most effective method was to trim away all of the branches and leave the trunk exposed. Slash treatment studies should be continued to determine the effectiveness of these or other methods under a greater variety of conditions than were found in the 1927 study.

Drought in Relation to Insect Epidemics

The importance of a deficiency of rainfall in causing insect epidemics was brought out in connection with the study of the losses on the Morrison area during the 22 years since it was logged. It was found that 45 per cent of the trees over 10 inches in diameter had been killed during the 22 years and that 80 per cent of this loss was caused by insects. The growth rate curve for sample trees on the area followed the precipitation curve very closely, and since 1916 both the precipitation and the growth rate have been below normal almost continuously. This is the period during which the infestation on the east side has increased until the losses are the heaviest of which we have any record.

This same relation of precipitation to growth rate and of growth rate to increased susceptibility is brought out by the sample plot studies and also by the following studies being made by Keen:

A series of long increment cores from western yellow pines have been secured from three widely separated areas - Idaho, southern Oregon and northern California. Periods of slow growth, as indicated by these cores, are to be correlated with insect epidemics of known occurrence and drought periods of the past.

During 1927 a series of 240 soil samples were secured from the sample plots in the Southern Oregon-Northern California area. Through cooperation with the University of California, Soils Division, standard moisture equivalents were determined for the series. These are to be correlated with epidemic conditions on the sample plots to determine to what extent the water-holding capacity of a soil is a factor in barkbeetle epidemics.

Most of the tabulations and computations on this project have been completed and the results can soon be put into report form.

Relation Between Insects and Fire Damage

The field work on the Northfork burn, which has been studied since 1924, has been completed and a final report will be made this winter by Miller. A preliminary report showed that the number of trees killed outright by the fire was much smaller than the number of fire injured trees subsequently killed by insects. This insect loss was concentrated on trees which suffered a 50 to 100 per cent defoliation from the fire. This defoliation caused a checking of the growth and missing rings on many trees. A number of trees still alive in 1927

had no visible growth since the fire.

It seems evident from this study that the heavy insect loss following fires is not caused so much by the attraction of beetles from adjacent timber resulting from the odors of burning timber as by the lowering of the vitality of the stand which causes a marked increase in its susceptibility. To test this point further a group of eight trees on the Cascadel area were burned in varying degrees with a controlled fire. The trees were burned in May during the first flight period of the beetles and no attacks were made until August when the only effect of the fire that remained was the weakened condition of the trees due to defoliation.

These studies encourage the belief that in general the effect of fire, from the insect standpoint, is similar to that of drought and that any factor that seriously reduces the vigor of a western yellow pine stand increases its susceptibility to attack by the western pine beetle.

In connection with the Southern Oregon-Northern California pine beetle surveys, a number of burned plots of 640 acres each have been studied to determine the history of infestation as influenced by and subsequent to different types of forest fires. The first effect of fires on insect infestations has been thoroughly covered in studies made by Miller, Patterson, Person and others. On these plots the history of the infestation during the period of recovery of the burned stand is being studied. Data will have to be taken for several more years before results are available.

Regional Survey of Insect Damage

The status of this project is the same as when last reported. While we have a general idea of the extent of insect damage throughout the state and detailed information concerning a few areas no effort has been made to "fill the gaps" or to incorporate the whole into a complete report. It would be very desirable to have the results of such a survey included in the type map now being worked out by the Experiment Station.

The study of insect losses on cut-over areas has brought out the need of special treatment for areas which are especially subject to heavy losses from insects. Before our knowledge can be applied generally, it will be necessary to have our timbered areas, western yellow pine especially, mapped according to probability of insect damage.

The completion of this study is dependent upon a special assignment to this project which is not possible with our present personnel.

REPORT OF OFFICE OF FOREST PATHOLOGY

Project

Cull per cent in white fir.

Purpose

To determine rate of decay and its bearing on utilization and management.

Status

Work begun in 1911, and preliminary results published. Work in 1925 was cruise of white fir on Modoc and Plumas National Forests as basis for deciding changes in present marking practice. Results compiled in form of curves showing relation of decay to age, size, and distribution within commercial range of species. Cull per cent tables over diameters worked up and now in use in Forest Management.

Plans

Cull per cent tables over age to be worked up. Study to be extended when funds become available.

Assignment

E. P. Meinecke.

Project

Slash disposal.

Purpose

To determine rate of decay of slash of different species, in piles or scattered.

Status

Experimental piles established on Stanislaus National Forest in 1923 (see also project Mb-1). These piles examined in 1924, 1925 and 1926. Some loss of piles in 1924 and 1925 by fire. Additional piles put up in 1924. A new set of plots partly with piled slash, partly with scattered slash established under East Side conditions (Lassen National Forest). On the Stanislaus plots the piles are much flattened out from the weight of snow. Needles and small stuff are breaking down to a point where fire hazard is much reduced. Decay of larger stuff still little advanced.

Plans

Inspection of both sites in 1928. Completion indefinite.

Assignment

E. P. Meinecke.

Project

Decay in western yellow and sugar pines.

Purpose

To determine loss from decay in trees of different ages and sizes, and in the stand as a whole. Data to be used in timber sales, in timber appraisal and in predicting loss in growing forests.

Status

Besides older data, the information resulting from studies in 1924 and 1925 on the Stanislaus National Forest have been compiled and results are available in the form of curves. Data have been worked up in cull per cent tables over diameter.

Plans

Study to be continued as funds permit.

Assignment

E. P. Meinecke.

Project

Killing diseases in reproduction.

Purpose

To determine type and amount of loss from killing diseases in young stands and consequences of the damage. The study aims at establishing principles for appraisal of loss in reproduction.

Status

Detailed plots studies on Shasta National Forest in 1923. Results described in manuscript, "The Evaluation of Loss from Killing Diseases in the Young Forest", to appear in March number of Journal of Forestry.

Plans

Additional studies on other fungi as funds are available.

Assignment

E. P. Meinecke.

Project

Mistletoe in second growth western yellow pine.

Purpose

To determine rate and distance of spread of mistletoe as a basis for marking.

Status

A permanent plot on Plumas National Forest laid out in 1920 and mistletoe eradicated. No examination made 1923-1925. Re-examined in 1926. New plots established on Lassen in 1926. Re-examined and cleaned in 1927. The Plumas plots are now considered free from mistletoe. The observation of reinvasion from the outside begins with this year.

Plans

Study to be continued.

Assignment

E. P. Meinecke.

Project

Frost injury in Douglas fir.

Purpose

To determine the extent of deforming and growth retarding influence of frost with special reference to the influence of topography and immediate surroundings.

Status

Systematic observations on effect of immediate surroundings and readings of march of temperatures at Feather River Experiment Station during 1927. Data analyzed and microscopic examinations made in laboratory. Data assembled ready for writing up in manuscript form.

Plans

Observations to continue at Feather River. Study to be extended to a general survey of frost belts to determine bearing on Douglas fir reproduction.

Assignment

W. W. Wagener.

Project

Examination of camping grounds.

Purpose

To determine the effect of concentrated tourist traffic upon the tree growth of camping grounds, and to devise means of

preventing further damage.

Status

An examination of a large number of public camps and recreation areas was made in 1927 on the Angeles. San Bernardino, Cleveland, Inyo, and Mono. Conditions calling for immediate remedial action and for the revision of recreation policy were found to exist on a number of camps. The data are now being assembled in form of a manuscript report.

Plans

To be continued.

Assignment

E. P. Meinecke.

Project

Relation between logging injuries and decay.

Purpose

To determine the extent to which injury to trees resulting from logging induces decay. Data to be used in timber sale supervision.

Status

No work in 1927 on account of lack of funds.

Plans

The study will be undertaken as soon as funds permit.

Assignment

E. P. Meinecke.

Project

Blue stain - Sugar Pine Lumber Company.

Purpose

To devise methods of preventing blue stain in timber cut in advance of railroad construction.

Status

Preliminary planning for a study in cooperation with the Sugar Pine Lumber Company is under way.

Plans

If funds are available the study will be begun in 1928.

Assignment

W. W. Wagener.

REPORT BY THE BIOLOGICAL SURVEY

Outline of Research being done in California

A. Studies in the natural habits of animals.

1. California ground squirrels
2. Moles
3. Mice and rats
4. Rabbits
5. Gophers
6. Porcupines

B. Experiments with poisons for rodents and coyotes.

1. Strychnine

a. Different forms of stychnine
b. Geletine tablets for predatory animal control
c. Different spreaders for carrying strychnine in rodent poisons

2. Thallium sulphate
3. Phosphorus
4. Arsenic and other poisons

C. Experiments with gases against rodents.

1. Carbon bisulphide for wet weather
2. Liquid cyanide for dry hot weather

D. Investigation of the damage done by birds in the fruit aections of the State.

1. Movements of birds
2. Location of food, water and shelter for birds
3. Kind and time that the birds do the damage.
4. Wood habits of birds
5. Working out methods of control

The program for the coming year will be a continuation of the lines of investigation in progress during the present year as outlined above with the possible addition of a study of the extent of the rodent disease "Tularemia" among the wild animals in the state.

REPORT BY THE OFFICE OF BLISTER RUST CONTROL

Experimental work dealing with the control of white pine blister rust in the sugar pine areas of District 5 was initiated by the Office of Blister Rust Control in 1926. Two projects were started that year, namely, experimental Ribes eradication, and control reconnaissance. During 1927 these projects were continued.

Experimental Ribes Eradication

This project is properly divisible into two sub-projects: eradication by means of the mechanical destruction of bushes and eradication by means of toxic chemicals.

Experimental Eradication by Hand Pulling

Purpose

The purpose of this work is to develop and perfect practicable methods of protecting sugar pine by means of mechanically destroying wild Ribes. The acquisition of cost data, on an acreage basis, for the different sugar pine types is also an important consideration in the experimental work, although in the early stages of the development of methods, is of secondary importance.

Location of Area

The experimental area was located on the Stanislaus National Forest. It included all or part of 13 sections in the southwest portion of T. 4 N., R. 18 E., M.D.M., During 1926 work was centered along the upper drainage of the North Fork of the Tuolumne River, between Coldspring and Pinecrest. In 1927 an area to the north of, and adjoining the 1926 area, including parts of the drainage of the South Fork of the Stanislaus River, a small portion of the Middle Fork of the Stanislaus River, and Herring Creek, was worked. This area contained a high percentage of sugar pine type and four species of Ribes: Grossularia roezli, Ribes nevadense, R. cereum and R. hallii. The first two species are by far the most prominent in the locality.

Results of Work

Experimental Ribes Eradication, California

1926

Eradication Type	Acres	Ribes	Ribes per Acre	Man days	Acres per man day	Cost per acre	Per cent of total Acres	Per cent of total Cost
Cut-over stream	87	43,817	504	120.5	0.72	$7.89	2.8	9.9
Cut-over S.P.-Fir	144	21,704	151	92	1.56	3.64	4.6	7.6
Cut-over S.P.-W.Y.P.	346	12,886	37	121	2.86	1.99	11.0	9.9
Mature stream	301	32,789	109	239.5	1.26	4.54	9.6	19.7
Mature S.P.-Fir	793	23,294	29	211.5	3.70	1.52	25.3	17.3
Mature S.P.-W.Y.P.	655	3,930	6	34	19.26	0.30	20.9	2.8
Brush	548	42,498	78	373	1.47	3.88	17.5	30.6
Thicket	125	65	0.5	2	62.50	0.09	4.0	0.2
Mixed)SP-WYP Mat.&)stream mat.	135	2,313	17	2.5	5.40	1.05	4.3	2.0
Total and average	3134	183,296	59	1,196.0	2.62	$2.22	100.	100.

1927

Cut-over stream	75.7	48,615	642+	176.31	0.43	13.81	2.13	14.81
Cut-over S.P.-Fir	908.5	101.292	111+	595.42	1.52	3.88	25.69	49.93
Cut-over S.P.-WYP	1133.3	34,995	31-	172.63	6.56	0.91	32.05	14.66
Mature stream	74.6	5,992	80+	49.74	1.5	3.96	2.11	4.19
Mature S.P.-Fir	353.9	13,481	38	113.62	3.1	1.89	10.01	9.51
Mature S.P.-WYP	990.4	6,665	7-	81.5	12.15	0.49	28.01	6.90
Total and average	3536.4	211,040	59+	1189.22	2.97	$2.00	100.	100.

1926-1927 Combined	6670.4	397,336	59+	2385.22	2.79	$2.10	--	--

A check on the efficiency of the 1926 work showed that 92.35 per cent of the bushes and 96.97 per cent of the live stem, or index of the potential infecting power, of the total Ribes originally on the area had been eradicated. The checking work in 1927 indicated that 94 per cent of the total bushes and 97 per cent of the live stem had been removed.

You will notice that the 1927 area, containing practically the same number of Ribes per acre, cost 22 cents less per acre to eradicate than the 1926 area. While this can be partially explained by differences in working condition, the decrease in cost was largely the result of a perfection in methods of eradication. Costs can be further reduced by continued experience and study of methods.

The results of our two seasons experience in this section of the Stanislaus Forest may be briefly expressed as follows:

a. The eradication of cut-over lands of over two years standing on any type is an expensive undertaking. The opening up of the timber stand results in the formation of considerable brush and Ribes, which means concentrated crew formation and slow progress, with a resultant high cost.

b. The eradication of uncut and unburned timber lands is a relatively easy task, amounting to from $0.30 to $1.89 per acre, depending upon the type.

c. A four-man crew for working areas of heavy Ribes concentrations and a three-man scout crew for working areas of few Ribes have proven to be most efficient in the Strawberry district.

d. Additional eradication data in other localities are necessary because of the varied conditions prevailing throughout the sugar pine belt.

Experimental Eradication by Application of Chemicals

Purpose

To develop chemical methods of Ribes eradication which may be cheaper and more efficient than hand pulling. Along certain stream bottoms and in old cut-over lands where Ribes growth is exceptionally profuse it is extremely difficult to make an efficient eradication by hand pulling. On such areas chemical methods are being developed and present results indicate that these methods will prove practical in eradicating dense concentrations of Ribes.

Location of Area

During 1927 a small scale experiment in chemical eradication was conducted on the Stanislaus Forest in conjunction with the hand eradication work. Prior to that time the work had been centered in Idaho.

Results of Work

Concentration of R. nevadense, R. cereum and a few bushes of G. roezli were sprayed with toxic chemicals to determine the reaction of California Ribes species to treatment developed for the Idaho region. The results of these rather meager experiments were gratifying and will pave the way for more extensive work.

Chemical eradication has progressed to such an extent in Idaho that it is to be carried out on a large scale application this season.

Reconnaissance

The Office of Blister Rust Control plans to make a rapid and systematic survey of the sugar pine areas of this district to determine the location and extent of the various eradication types and the average density of Ribes occurring thereon. This information is essential in the development of a general plan for the application of local control of blister rust.

Results of Work

In 1926 a small start was made on the Stanislaus Forest in the immediate vicinity of Strawberry. 944 acres were reconnaissanced. During 1927 the work was increased in size and a total of 186,952 additional acres of sugar pine type were covered. The cost of the work amounted to $0.0125 per acre. Of this acreage, 76,346 acres were worked intensively, at a cost of $0.0277 per acre, and 110,606 acres were worked extensively at a cost of $0.002 per acre.

Work Proposed for 1928

Experimental Ribes Eradication

Experimental Eradication by Hand Pulling

During the coming field season it is proposed to continue the experimental eradication work. The area selected for the project lies in the northern part of the Stanislaus Forest in the vicinity of Dorrington. More exactly, it occupies part or all of the 16 sections centered around the intersection of T. 5 and 6 N., R. 15 and 16 E., M.D.M. This area, of slightly over 10,000 acres, is made up entirely of uncut timber, largely sugar pine type. One of the chief problems of the season will be the development of a method to cheaply locate and eliminate the Ribes on such uncut timber areas.

Experimental Eradication by Application of Chemicals

Preliminary checks of work done in 1927 are sufficiently encouraging to justify further experiments. It is planned to make more applications of chemicals to the principal Ribes species of the sugar pine belt.

Control Reconnaissance

The Plumas National Forest will be reconnaissanced in 1928. It is planned to cover a sufficient number of representative areas on this forest so that a general conception of eradication condition on the entire forest can be obtained.

Studies in Ribes Ecology

The past two seasons in experimental Ribes eradication on the Stanislaus Forest have shown the need for special ecological studies concerning the life history of Ribes. Ribes eradication data thus far obtained show possibilities of control measures of such significance that special studies are to be undertaken to get at the facts in the case.

The data thus far obtained on the various timber sale areas of the Strawberry locality bear out the following observations:

a. There are relatively few Ribes on any mature timber area which has been undisturbed by nature or man.

b. On newly logged areas of not over two years standing, Ribes have not increased to any material extent.

c. On any of the older cutting areas, Ribes are very abundant, the number present on an area increasing directly with the lapse of time since cutting.

Following logging, with the consequent opening of the stand and the exposure of mineral soil, reproduction and establishment of Ribes, especially G. roezli, occur on a large scale. The opening of the stand stimulates the veteran bushes, which escape destruction, to profuse fruiting and the exposure of mineral soil seems to facilitate germination. While the mortality of seedlings is very high, a sufficient percentage of the large number establish themselves, so that a formidable ribes flora is started. This increases for a considerable period. The stand closes slowly and the new bushes come to maturity and vigorously reproduce before their fruiting is retarded by forest growth. The apparent lapse of one or two years after logging before any appreciable amount of new Ribes show up indicates that the new bushes are the result of seed either stored for long periods in the duff, or produced after veteran Ribes have had a chance to bear fruit.

The purpose of the ecological studies to be undertaken in 1928 is to determine the effect of forest growth on Ribes reproduction and establishment. An effort will be made to answer such questions as the following.

1. Does Ribes seed remain in the soil or duff under storage conditions?

2. Does old stored seed or fresh seed produce the young plants?

3. How long before the young plants begin to produce fruit?

4. How soon after logging do new plants begin to appear?

5. What is the effect, on the number of new plants, of removing the veteran Ribes just prior to logging?

6. What is the effect of fire, donkey logging, tractor logging on producing new plants?

7. How soon and how many seedlings appear around the spots where eradicated bushes grew?

Detailed investigation of these and other points may have not only a profound influence on the Ribes eradication program, but may result in recommendations to the foresters of practices which, while not contrary to recognized silvicultural practice, may greatly aid in eliminating or keeping to a minimum the growth of Ribes within the sugar pine type.

REPORT OF THE WEATHER BUREAU

Since this meeting is one dealing chiefly with the investigative sides of forest problems, the organization and regular work of the fire weather service will be touched on only briefly, in order to give the necessary background for a discussion of the Weather Bureau investigative program.

The Fire Weather Service of the Weather Bureau

The fire weather service of the Weather Bureau has been in operation on an organized scale in California for two fire seasons. During that time the principle activity has been the work of establishing the basic organization necessary for future progress in the work. The work of the fire weather service may be divided into three general lines of activity:

1. The formulation and dissemination of special fire weather forecasts.

2. Field work in connection with the organization of the project.

3. Studies, compilations and investigations of fire weather data.

Fire Weather Forecasts

Fire weather forecasts have been issued during the past two seasons whenever required in the judgment of the forecasters, and occasionally upon special request from certain Supervisors. These forecasts have been couched in general terms and applied to major areas or districts.

Types of Forecasts

The types of forecasts which have been issued and which will be continued are -

1. Short range forecasts for one or more days in advance when the weather charts indicate changes in fire hazard of a radical character.

2. Advices of the prospective termination of a period of marked fire hazard.

3. Issuance of a general outlook for several days in advance on occasions when weather charts presented features of sufficient significance.

4. Special more-localized forecasts sent to supervisors engaged on going fires, on request, issued for a period of 12 to 24 hours in advance, not oftener than twice a day, based on the a.m. and p.m. weather charts.

Bases of Forecasts

The special fire weather forecasts are based on twice daily reports from about 200 land and vessel observation stations and daily telegraphic reports from 23 forest stations in California.

Dissemination of Forecasts

The special fire weather forecasts have been disseminated by radio broadcasts from three important California stations, they have been published in all of the large city newspapers and on the San Francisco and other daily Weather Maps (700 copies issued at San Francisco), and they have been disseminated by direct telephone and telegraph messages to a list of 50 recipients, public and private, throughout the state; these recipients made further local distribution of the forecasts.

Localization and Accuracy

Some progress made on a thunderstorm and lightning fire study during the winter of 1926-27 resulted in improvements in thunderstorm forecasts during the 1927 season. The state was re-districted for fire weather forecasting purposes early in 1927, and this re-districting also aided in improvements in forecast localization. Further advances in forecasts necessarily must await the completion of absolutely essential studies, these studies depend in turn on records, and records can be secured only through the establishment of survey stations. The statewide network of stations is now well on the road to completion.

No material changes in forecasts are contemplated before the completion of studies, but more telegraphic reports from each forest will be available in 1928. With this better basis for forecasts, it is expected that the degree of localization and accuracy will be improved. The completion of the thunderstorm and lightning fire study for California before the opening of the 1928 season is expected to contribute materially to the bases for forecasting fire causing thunderstorms.

Field Work

The field work of the fire weather service consists of the establishment of record keeping and telegraphic reporting stations on forest areas, the thorough instruction of observers, visits to going fires for study data, and miscellaneous organization and cooperative work, especially with the California Forest Experiment Station in connection with their meteorological activities at their "centers of work".

Fire Weather Survey

The most essential part of the fire weather organization is the survey.

Objects

The objects of the survey are -

1. To secure the basic meteorological and climatological information required for studies intended to increase the accuracy and degree of localization of the special fire weather forecasts.

2. To add to the existing knowledge of mountain and forest climates.

3. To secure information in the form of normals, means or averages which will result in contributions to useful fire weather knowledge, or which will be practically utilizable in the following general ways:

a. Devising general fire plans.
b. Determining normal course of action on "going" fires; in other words, fire fighting tactics as they are influenced by general weather relations.
c. General forest activities; ordinary daily work; grazing, silvicultural, telephone, road and trail and general improvement work.
d. Making forest studies other than those relating to fire (grazing, silvicultural, other technical investigations).

Methods

A brief discussion of the methods being used to conduct this survey seems appropriate. All forest areas are visited through extensive travel each season and numerous points are inspected. Selections of suitably located stations are made, the observers instructed, instruments installed and records and telegraphic reports started. A number of paired stations are being established; that is, two stations close together horizontally but differing widely in elevation are selected and equipped similarly; the records from this type of station are believed to be of great potential value in connection with forecasting local thunderstorms and in investigations of "lapse" rates or altitudinal differences of the various meteorological elements.

Accomplishments

During two seasons of field work and travel, 47 survey stations have been established and equipped. Telegraphic reporting stations numbering 23 have also been established. The forest areas of

southern California from the Sequoia southward have been nearly completely covered with the required survey network. The northern forests at present have only high level telegraphic reporting stations.

Needs and Proposals

In order to adequately cover the forest areas of California, it is estimated that a total of not less than 120 survey stations will be required for the complete network. Most of these will be established and equipped by 1929. A large proportion of the stations established to date have been high level stations. Future stations will be established at lower levels in order to have a very complete altitudinal range.

Fire Weather Studies

The importance of fire weather studies under way and proposed cannot be over emphasized.

Weather Bureau Study Program, General Remarks

The studies in which the Weather Bureau is primarily interested are -

a. Forecast studies, aimed at making greater localization and accuracy of fire weather forecasts possible.

b. Fire weather relationships studies; analysis of meteorological conditions and fire weather relations, including normals, interrelationships of the principal weather elements and their variations with geographical position and elevation, and topographical influences on weather elements.

The problems involved in fire weather studies are complex. There is a pressing need for more or less immediate solutions. Those two considerations, together make a more than preliminary study of each problem at present out of the question. More and better records must accumulate before really thorough studies can be made. Studies are therefore being conducted with the aim of making them as complete and thorough as the records and time available permit. Studies will be revised and enlarged upon thereafter as experience and additional data may require.

Winter Work on Fire Weather Studies

As recommended by last year's committee, the most important study, that relating to thunderstorms and lightning caused fires, was undertaken during the winter months of 1926-27. Another study relating to the prevailing surface winds of the state was also started at that time. Neither of these studies could be completed before the opening of the 1927 fire season.

The work done on these studies in the early months of 1927 was of value, however, in the following ways:

1. Some of the necessary and somewhat difficult preliminaries to these studies were completed.

2. A good idea of the nature and limits of the problems involved was secured.

3. A sifting of plans and methods was accomplished which will expedite future work.

4. Some tentative results of value were secured and used to good advantage in making the fire weather forecasts during the 1927 fire season.

Outlook for Studies

The factor of lack of time preventing early completion of fire weather studies will henceforth not be so important as was the case in 1926-27. The fire weather official now has full time for this work, and several additional members of the San Francisco station force are assisting with the voluminous compilations required. It is believed that the thunderstorm and lightning fire study will be completed before the opening of the 1928 fire season. The other studies listed will be undertaken and completed as rapidly as practicable.

Discussion of the Thunderstorm Study Now Under Way

This is the most important study now being conducted. It may be divided into two parts:

1. The determination of the general characteristics of thunderstorms and lightning fires in California.

2. A study of means for successfully forecasting and localizing forecasts of fire-causing thunderstorms. This involves a correlation of data secured in 1 above with detailed twice daily weather charts and other records. The object is to determine the combinations of conditions which result in GENERAL storms causing lightning fire PEAKS on certain forests of the state.

It is believed that certain kinds of weather maps will prove to be typical of conditions resulting in storms of a general fire-causing character. It is further believed that in most instances of storms of this kind that the chief factor in causing BOTH storm and readily burning fires has been a prolonged period of low humidity and high temperature immediately preceding the storm. This sort of period is believed to be intimately related to the "dry" type of storm.

Sources of data being used are as follows:

Thunderstorms. Weather Bureau published thunderstorm summaries for the period 1897-1916. These are not sufficiently complete and their accuracy for the purposes of this study is open to question. This data

therefore cannot be used for the detailed correlation with weather charts, but necessarily must be used in compiling thunderstorm frequencies. It was thought that considerable labor would be saved through the use of these summaries, but under the circumstances laborious compilations from the original records are necessary.

Original records of observations taken at about 500 Weather Bureau cooperative climatological stations during the years 1906-1927.

Detailed lightning storm reports from a number of Forest Service lookout stations for the period 1923-1927.

Forest Service Monthly weather records for about 25 forest stations, for the same period.

There are a total of about 14,000 individual reports of thunderstorms which are being used in the study, extending over a maximum period of 31 years, from 1897 to 1927.

Lightning and Other Fires. Individual fire reports on file at the office of the California Forest Experiment Station, Berkeley, where they are being consulted.

Detailed abstract or summary of all forest and brush fires from all causes on all forests in California during the period 1911-1927. This is the District Fire Atlas, in many respects a very admirable record well suited for studies of this kind.

These fire records being used include reports on over 12,000 fires during a period of 17 years, from 1911 to 1927.

Factors Being Considered. The following are some of the factors being considered in this study: Total numbers, seasonal variations, monthly and decade averages, diurnal frequencies, temperatures, humidities, winds, clouds and upper air data before, during and after each storm, accompanying precipitation, differences due to elevation and location, directions and rates of travel of all storms (with charts of storm tracks), groupings by storms, showing numbers, burned areas, etc., the relation between the lapse rates of temperature to the occurrence of local storms, and many other phases.

Other Studies

Other studies on which work has been started but which has temporarily ceased in order that the thunderstorm study may be completed are -

1. A study of the prevailing surface winds of the state and the applicability of upper air data in forecasting surface winds at the higher altitudes.

2. Fire weather inter-relationships. Example, the relations between wind direction and relative humidity, the diurnal changes in all of the weather elements at different elevations, etc.

3. A study of low humidity periods, with special reference to methods of forecasting them. As a part of this study is included a study of the rates of spread of forest fires as influenced by weather conditions.

The foregoing list of studies constitutes the investigative program of the Weather Bureau in California for 1928. It is not expected that all of the studies can be completed, but that relating to winds will quite probably be completed and good progress will be made on the others.

General Statement of Proposals for 1928

The work of establishing stations and instructing observers will be continued more intensively.

A total of about 120 record keeping survey stations will be established, by 1929 if possible. Extensive travel and work in the field will start June 1. Visits will be made particularly to the northern California forests, to the east side Sierra forests, to the Eureka redwood region and to national park areas.

A large amount of instrumental equipment will be installed during the 1928 season, including recording instruments for temperature, humidity and wind.

The telegraphic reporting system will be extended to secure several reports from each forest, through the use of code.

The reports will be charted on a new and separate fire weather chart of which each sheet will contain all available fire weather information for a given day.

Cooperative activities will be continued and extended, particularly with the California Forest Experiment Station; and additional cooperation with State and private interests will be undertaken.

A new wind recording instrument for fire weather use is being devised.

A new set of instructions for fire weather observers is being compiled.

New humidity tables for all elevations which eliminate the necessity for arithmetical computations in reducing the observations are being prepared.

The San Francisco or Los Angeles Daily Weather Maps, at the request of the District Forester and of numerous individual rangers, will be sent throughout the year to all District Rangers in District 5 as a part of the weather educational campaign. The map is received at many stations in time for the forecasts to be applicable, but in any case the map has a distinct educational value.

The thunderstorm and lightning fire study will be completed and prevailing wind, fire weather relationship and low humidity studies will be undertaken.

A series of articles on weather are being prepared by the fire weather official for publication in the District News Letter as part of the educational campaign in District 5.

It is desired to continue the visits of the fire weather official both as instructor and pupil at the ranger training school held near Quincy each fall.

It is desired to make an airplane flight over northern California forests in 1928 similar to an airplane trip over southern California forests in 1927. This flight was helpful in securing adequate topographical impressions and in making evident general considerations which should govern the placing of survey stations.

Funds in 1926 amounted to $2575 for fire weather work in California, an increase to $3260 was secured for 1927, and a further increase to $4180 is recommended for 1928.

REPORT BY DIVISION OF FORESTRY, UNIVERSITY OF CALIFORNIA

The investigative work handled by the Division of Forestry during the past year together with plans for the ensuing year are presented herewith:

Mulford

While Mulford is doing work that really falls into the sphere of research in forest economics, it is not carried out under any specific project and is not in a condition to report at the present time.

Krueger

During the past year work has been carried out on a tractor study, five groups of studies having been made. Tabulation of results has been completed in all five and the numerical work has been checked. In only two cases has the data been completely worked up in a semi-final form. The remaining three will be complete before July 1. It is already obvious that insufficient work has been done to show clearly the effect of slope in caterpillar logging. During the summer, work will be done to gather sufficient data to work out the effect of slope in an accurate manner and the project will be completed and ready for publication some time in the fall.

Another project dealing with the classification of forest lands is still open and alive although no work has been done upon it for some time. With the completion of the tractor study problem Krueger expects to undertake this study, which involves a compilation of figures on ownership and general condition of timber lands in California. It is entirely distinct from the land classification work being carried on by the Forest Service. Originally the project called for a survey of the entire state, but as this seems much to large for a single man it probably will be restricted to a single region not yet chosen but very possibly the redwood region.

Fritz

Since Fritz took his sabbatical leave last year there is little to report in way of progress in research work. A definite project, however, was an investigation of the cause of staining enamel paints on sugar pine. A remedy for this was discovered. For the ensuing year the study of standing on sugar pine will be conducted, but in addition an investigation of shrinkage in standard size lumber will also be undertaken.

Another project which has been started this year concerns itself with the logging and milling of virgin redwood, and has for its principal problem the determination of the amount and reasons for the breakage and other losses occurring between the stump and sorting table,

as well as the cost of logging and milling trees of various sizes.

Baker

The first section of work dealing with a complete study of the physiology and ecology of coniferous seedlings covers the effect of direct high temperature upon seedlings. The essentials of the matter were pretty well worked out but some of the minor details required to round out the problem in a thoroughly scientific manner still remain to be covered this year. The results confirm the studies of Hartley and many others, showing the injurious effect of solar heat to be concentrated at the ground level line where it appears in the form of an injury superficially somewhat similar to damping off. It was fairly well established that the different species of conifers all perish when the temperature of the interior of the cell reaches about 130°F., but that this critical internal temperature is not reached in large stemmed species until the external temperature is considerably higher. The surface of the soil may become as much as 30° F, hotter before Coulter pine stems are killed, but with small, frail stems as found in spruce, western red cedar, etc., the internal temperature is virtually the same as that of the surroundings. Resistance to injury from direct heat is therefore a function of the size of the primary stem.

Schumacher

During the last year yield studies and volume tables for red fir were prepared and manuscript has been completed to be published in 1928.

At the present time a yield study of Douglas fir in California is being carried on. The field work has been completed and the compilation is now under way. Special attention will be given to checking the volume tables and yield tables against those prepared for Douglas fir in the northwest by Munger and McArdle.

For new field work during the year, a study of the stem form of the Sierra timber trees is proposed with special reference to Dunning's new tree classification. Western yellow pine will first be considered with the object of determining whether change in form of trees left standing after logging is confined to certain tree classes or is common to all trees. The second object will be to determine whether volume shows a higher correlation with site class tables, as used now, or with tree classes for all sites.

Sampson and Malmsten

Work is continuing on the general project covering the revegetation and maintenance of California foothill ranges along several avenues of approach.

The section dealing with range improvement by reseeding, which has been under way for a number of years, has shown by a series of plots and quadrats in 17 counties that revegetation by deferred grazing has wide possibilities in the foothill types, and that reestablishment of the best forage species is rapid where growth conditions are favorable. In the regions of low annual precipitation succession and revegetation is much slower. In the fall of last year a laboratory study to determine the rate of growth of various annual and perennial grasses where the original fertile soil has been partly or wholly removed was initiated at Berkeley, using soils procured near Placerville, Sonora, and the local Berkeley soil. The object is to determine how succession is modified by erosion in these different soil types.

The study of range improvement by burning has been continued and in 1927 studies of high temperature tolerance of seeds of various shrubs and herbs have been made in the laboratory, and sample plots of burned and unburned check areas were remapped. Certain soil analysis have also been made, and the beginning of a garden of native California shruns was made in cooperation with the California Forest Experiment Station.

The nutritive qualities of forage types and food stores in roots have been laid out and recently 12 sample plots were established in the Berkeley hills and 12 more near Danville. These plots are harvested with varying frequency to correspond with similar work being carried out in five different counties to determine the nutritive qualities and yields under the different methods of procedure. Certain digestion tests have been made in cooperation with the Division of Animal Husbandry, which have shown much less digestible protein in October and November than in the end of the growing season in June. The stores of food in the roots and crowns of Stipa pulchra were determined in 1927, and it was found that food stores decline sharply during early spring growth but that they increase at the end of the first growing month and thereafter maintain a high level to the end of the growing season. This section of the project should show the advisability of supplemental feeding during critical periods and the fundamentals governing the period and frequency of grazing with a view to maintaining the productivity of the range.

In the section of the project dealing with the management of deer, the food habits of the deer have been studied by extensive observation, mostly in Mendocino County. A catch of deer at the Henshaw ranch is planned for this spring and a careful study of the life history and of foraging habits will be initiated. A collection of deer forage species has been made and rather detailed notes have been taken.

REPORT OF THE EDDY TREE BREEDING STATION

Methods of Selection

Species Tests

The object of this project is to make thorough nursery and plantation tests of all known species of pines under various conditions, to to determine such matters as rate of growth, adaptability, hardiness, quality of wood, etc. It is therefore desired to have the various little-known species planted in as many different parts of the state as possible. Small lots of trees for experimental planting are distributed without charge, while large lots are supplied at the cost of digging and packing.

Report for 1927

Our 1926 nursery plantings contained seedlings of 18 species of pines, even though at the time these beds were planted we had not decided to specialize on pines. A total of about 40,000 2-0 pine seedlings were dug up during January 1928 and distributed in the following ways: (1

1. Planted in our arboretum
2. Planted out by us in 3 small plantations on the Eldorado National Forest
3. Planted out in other plantations on the same forest by Forest Service men
4. Supplied to the California Forest Experiment Station for use in three places, namely, Devil Canyon, Feather River, and on the Stanislaus National Forest
5. Supplied to California State Division of Forestry
6. Supplied to four local organizations in the southern half of the state, and shipped through the cooperation of Professor Metcalf and M. B. Pratt.

The nursery plantings that were made in the spring of 1927 contain seedlings of 49 species and nine varieties of pines, making a total of 58 separate kinds, all of which will be available for distribution late this fall.

Plans for 1928

A large part of the 1928 nursery plantings are to be given over to this important project. Already seed has been brought together of 74 species and varieties of pines from about 20 different countries in all parts of the northern hemisphere. Some of these species have been secured from as many as 10 different sources. In order to eliminate as far as possible the effects of varying environmental conditions in the nursery, each lot of seed of the important species will be planted in

triplicate plots, while the minor species will be planted in duplicate plots.

Progeny Tests

Report for 1927

Our first small planting of Progeny Tests, including duplicate plots of seedlings from 53 individual mother trees of western yellow pine, 80 trees of Monterey pine and 70 of sugar pine, are now one year old. Already pronounced differences have appeared in the germination of the seed and in the appearance of the seedlings from different trees, even when the parent trees are in the same plot occupying only a few acres.

Although every effort has been made to maintain uniform conditions throughout the nursery, considerable difficulty has been experienced in interpreting the height and diameter measurements that have been taken on the one-year old seedlings, due to the fact the repeat planting frequently does not agree with the original planting.

Questions for Discussion

1. Should the selection of the best progenies be based upon the average growth of the two plots or upon the growth made in the best plot of each, assuming that the poor development which sometimes occurs in the other plot, is due to unfavorable local conditions in the nursery?

2. Is there anything to be gained by measuring in detail all progenies, or would it be sufficient to measure the 50 per cent of the best ones, as judged by appearance?

3. Is an average based upon 25 seedlings per plot, selected mechanically in 5 lots of 5, sufficiently accurate? Should the measurements include all sizes of seedlings in the plot, or only the dominant ones?

Walnut Progeny Tests

A full report on this experiment, which is being carried on at the State Nursery in cooperation with the California State Division of Forestry, will be delayed until next year, as it is difficult to judge the relative value of the different progenies of black and hybrid walnuts when the seedlings are only one year old, as the hybrids are said to make their main growth the second year. The planting contains approximately 50 seedlings from each of 250 of the largest and most rapid growing as well as many ordinary walnut trees that could be found on the Pacific Coast from southern California to Washington; and also seedlings of eastern black walnuts from New York, Arkansas and other states.

Plans for 1928

The 1928 nursery plantings will include over a hundred progenies of Monterey pine and about an equal number of western yellow pine. Through

the kind cooperation of the different forest experiment stations, we have secured seed of the species from individual trees in Arizona and Colorado, in addition to what we collected in Oregon and California. A great variation has been found in the size, form and color of the seeds from different trees of western yellow pine growing in the same plot in Eldorado County, making it clear that each tree in a stand is different from every other one, and that geographical differences are not the only ones to be found within this species.

In the fall of 1928 it is planned to very materially enlarge the work of seed collection for Progeny Tests, in order to take advantage of the heavy cone crop that is expected on the western yellow pine. It is hoped that it will be possible to secure seed from about 800 individual trees scattered as widely as possible throughout the range of the the species. While some seed will be taken from poor sites, the most of it will come from fine-appearing individuals on good sites, and in the localities where growth is most rapid.

Questions for Discussion

1. What localities would it be especially desirable to have represented in these tests?

2. How can information best be secured as to crop conditions and time of ripening in different localities?

3. What variations in the form of the tree, or in other characters, have you noticed that might be shown to be inheritable by tests of the progeny? Examples: Twisted grain; individuals comparatively free of lower branches, yet growing in the open, and unpruned.

Methods of Pollination

Report for 1927

The small amount of pollination work that was done in the spring of 1926 yielded in the fall of 1927: 29 seeds of the cross of western yellow pine pollinated with Digger pine and 24 seeds of the cross of western yellow pine X Swiss Mt. pine. Weights of the hybrid seeds indicate that most of them are probably fertile. No western yellow pine unpollinated "checks" produced good seeds, indicating that the pollination technique is satisfactory.

During the spring of 1927 pollination work was completed on 9,664 pine flowers, involving 99 species crosses. The work also included a large number of self pollinations and crosses between trees of the same species.

A partial count recently made of the set of the 1927 pine pollinations indicates that quite a number of species crosses will probably be successful, including among others:

Western yellow pine	X	shortleaf pine
" " "	X	longleaf "
" " "	X	Loblolly "
" " "	X	Scotch "
" " "	X	Austrian "
" " "	X	Italian Stone pine
" " "	X	Rough-branched Mexican pine
Monterey pine	X	slash pine
" "	X	longleaf pine
" "	X	shortleaf "

Plans for 1928

Pollination work this season will be confined principally to the use on western yellow pine and Monterey pine of pollen of the southern pines and of pines growing in various subtropical countries. Already this spring's pollen has been used of Pinus oocarpa from Honduras and Pinus insularis from the Philippine Islands. Pine pollen is expected from Mexico, Cuba, Guatemala, India, the East Indies, and other southern countries.

Cultural Experiments

Only tentative results are available at this time, as both of these experiments have been running only one year.

Spacing and Irrigation Experiment

This experiment consists of duplicate plots of western yellow pine and Monterey pine planted at each of the following densities: 16, 25, 36, 49, and 196 seedlings per square foot. One entire set of these plots is given medium irrigation (6 hours sprinkling with the Skinner line twice a week); another set is given heavy watering (sprinkled 4 times a week); and a third set is lightly irrigated (sprinkled once a week).

Measurements on the Monterey pine seedlings have shown that under all three degrees of irrigation, both the height and diameter of the seedlings are inversely proportional to the number of seedlings per square foot. The medium irrigation has given the largest trees, while the light watering gave the trees that were uniformly the smallest. Data on the western yellow pine seedlings are now being worked up.

Questions for Discussion

1. It is evident that the density of the plot materially affects the size of the trees, and the question is raised if it would be feasible to apply a correction factor to height and diameter measurements taken on plots where the density does not come up to the standard density for Progeny Tests and Species Tests, namely 36 seedlings per square foot.

2. Under what conditions, if any, will crowding cause trees to grow taller?

Time of Sowing Experiment

This project has been conducted with western yellow pine and sugar pine, starting sowing in the fall and planting duplicate plots of each species every three weeks until late spring.

The common difficulty in securing good germination of sugar pine was entirely overcome by the fall and winter sowing, as these plots have a full stand of seedlings. The tallest trees were produced by the sowing made on November 19, and the conclusion is reached that for every 5 days later than this that the seed is sowed, the 1-0 seedlings will be about .01 foot shorter. In the case of western yellow pine, the December 31 sowing resulted in the tallest seedlings, and for every 8 days later than this that the seed was sowed, the 1-0 seedlings were about .01 foot shorter.

Rate of Growth of Pines

Questions for Discussion

1. How can one accurately determine which species of pines are the most rapid growing, considering the great difference in sites,, and the different densities under which the species normally grow?

2. What is most needed in order to shorten the rotations on which pines are grown - more rapid height growth, or more rapid diameter growth?

3. Would it be safe to measure only height growth, or only diameter growth, of Progeny Test plots of nursery seedlings, whichever is considered most important?

REPORT OF EXTENSION FORESTER

Effectiveness of Windbreaks

Instrumental records obtained at Fontana, San Bernardino County and King City, Monterey County, show:

1. Blue gum windbreak is very effective in preventing damage to orchard crops for a distance 5 to 6 times its average height. At 12 feet from ground a 35-foot windbreak reduces a 20-inch wind to 7 miles at 100 feet and to 10 miles at 200 feet in its lee. Wind of 30 to 49 miles per hour in the open was reduced to 15 miles and less at a point 310 feet from a 65 foot windbreak.

2. Windbreaks require irrigation, fertilization and root priming in order to be of maximum benefit.

3. Athel (Tamarix articulata) is not a good windbreak tree except in Imperial Valley and similar desert sections. It is too brittle and not of sufficient ultimate height.

4. Monterey cypress (Cupressus macrocarpa)is dying out fast in many interior windbreaks because of bark beetle attacks. It cannot be recommended for use except in the coast counties.

Wind records will be continued at the above stations and are now being supplemented by evaporimeter records with Bates instruments. One set of anemometers will probably be used in the Altamont Pass section during the summer.

Test Forest Plantations

Using stock from the Eddy Tree Breeding Station, plantations of pines including longleaf, shortleaf, loblolly, Table Mountain, Bishop, Monterey, western yellow (Californian and Rocky Mountains), Canary Island, cluster, sugar, and white are being planted this spring at

Santa Cruz Demonstration Forest #1	
Kern River Park	Kern County
Stookey Ranch	" "
Murphy Ranch	Los Angeles County
Fricot Ranch	Calaveras County

Check on survival and adaptability of these species will be made.

Effect of Thinning Redwood Second Growth

1. The two plots in 50-year-old growth at Arcata Park, Humboldt County should be remeasured this year (5th).

2. The Big River plot cut in 1923 should be examined and possibly half of it thinned if time and money can be allocated to this project.

3. A good opportunity for future work along this line is furnished by the Santa Cruz Demonstration Forest, logged in spring, 1927 and now planted.

A P P E N D I X

CALIFORNIA FOREST EXPERIMENT STATION

Personnel

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C. J. Kraebel	
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R. B. Weaver)	Devil Canyon Branch Station
_____)	Feather River Branch Station

Clerical -

D. H. Vinther
L. O. Baxter
F. Towle
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California Forest Experiment Station

Estimate, F. Y. 1929 (exclusive of Products)

Salaries	$32,800	
Expenses	7,550	
Field Assistants and labor	5,000	
Equipment and supplies (including construction at Devil Canyon)	4,220	
Telephone, telegraph, postage	480	
Freight, express, hauling	400	
Miscellaneous	800	
		$ 51,250

Estimated Appropriations

Federal -		
S.I.	30,000	
G.E. (Clerical)	3,600	
G.E. Improvement	150	
Cooperative -		
State	7,500	
Other	10,000	
		$ 51,250

Office of Forest Products

Salaries	7,300	
Expenses	1,100	
Miscellaneous	950	
		$ 9,350

Estimated Appropriations

Forest Products	9,200	
Census Bureau	150	
		$ 9,350

List of Articles Prepared or Submitted for Publication

California Forest Experiment Station

Fire in relation to forest cover types. Show and Kotok. (Submitted for Department bulletin.)

Statistical analysis of forest fires northern California, 1921-1926. Show and Kotok. (Prepared.)

Forests in relation to water in California. Kotok. (Submitted as chapter for a school book of forestry to be published by California Development Association.)

The California Forest Experiment Station. Kotok. (California Countryman, January, 1927.)

Marine borers and their relation to marine construction on the Pacific Coast: Final report of San Francisco Bay Marine Piling Committee. Hill. (One of the editors-in-chief.) Book, 1927.

What forest waste means to the railways. Hill. (Proceedings, Pacific Railway Club. Sept., 1927.)

What the McSweeney Bill means to California. Hill. (California Journal of Development. 1928.)

The utilization of woods and sawmill waste, with special reference to pulp and paper. Hill. (California Journal of Development, February 29, 1928.)

Thinning young woodlands. Dunning. (Submitted for Department leaflet.)

Forest types of California. Dunning. (Submitted as chapter in school book of forestry to be published by the California Development Association.)

Preliminary study of the roots of Pinus ponderosa Dougl. Dunning. (Prepared.)

Some results of cutting in the Sierra forests of California. Dunning. (Revision of Department bulletin 1176.) (In preparation.)

The Devil Canyon Nursery. Kraebel. (Prepared for Forest Worker.)

Distribution of rainfall in the Barranca Burn. Kraebel. (In preparation.)

Erosion control in Japan. Lowdermilk. (The Oriental Engineer, Peking, China, March, 1927.)

The Forestry of Japan. Lowdermilk. (Journ. Forestry, 25:6. 715-722. 1927.)

The third Pan-Pacific Science Congress. Lowdermilk. (Journ. For., 25:7. 873-884. 1927.)

Notes on the problem of field erosion. Lowdermilk and J. R. Smith. (Geogr. Rev. 1:2. 226-235. 1927.)

Wind sown tree crops. Siggins.

Jeffrey pine and its relation to western yellow pine. Tihomiroff. (Prepared.)

Bureau of Entomology

Preliminary studies on the relation of fire injury to bark-beetle attack in western yellow pine. J. M. Miller and J. E. Patterson. (Journ. Agri. Research, 34-7. 597-613. 1927.)

The relation of highway slash to infestations by the western pine beetle in standing timber. J. E. Patterson. (U. S. Dept. Agr. Technical Bulletin No. 3. 1-10. 1927.)

The relation of insects to slash disposal. Division of Forest Insect Investigations, Bureau of Entomology. (U. S. Dept. Agr. Cir. 411. 1-12. 1927.)

Solar heat control of the mountain pine beetle in lodgepole pine. J. E. Patterson. (Prob. Jour. Forestry.)

Tree classes selected by the western pine beetle. F. P. Keen. (Prob. Jour. Forestry.)

Relation of soil moisture to western pine beetle epidemics. (F. P. Keen. (Forest Worker.)

Windfalls as a factor in barkbeetle epidemics. J. M. Miller. (Forest Worker or Journ. Forestry.)

Slash disposal methods in the control of barkbeetles attacking western yellow pine. H. L. Person. (Journ. Agri. Res.)

Tree selection by the western pine beetle. H. L. Person. (Prob. Jour. Agri. Res.)

The effectiveness of different western yellow pine "line" slash disposal methods in insect control. H. L. Person. (Forest Worker.)

Barkbeetle infestations on cut-over areas. H. L. Person. (Prob. Timberman or Forest Worker.)

The importance of the clerid, Thanasimus nigriventris, in the control of the western pine beetle. H. L. Person. (Prob. Jour. Agr. Res.)